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WRITING GUIDE
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a) The title is written in English and informative, concise, and not too long or short (10- 25 words).
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c) Research objective.

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c) Method of data analysis.

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e) A serial number that is used is number 1, 2, 3, and so on, do not need to use a composite number. Hyphens should not change the serial number.

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a) Contain conclusions and recommendations.
b) Conclusions contain answers to the research questions.
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Casadei, D., Serra, G., Tani, K. (2007). Implementation of a Direct Control Algorithm for Induction Motors Based on Discrete Space Vector Modulation. *IEEE Transactions on Power Electronics*,*15(4), 769-77.* doi: http://doi.org/10.1109/63.849048

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McKenzie, H., Boughton, M., Hayes, L., & Forsyth, S. (2008). Explaining the complexities and value of nursing practice and knowledge. In I. Morley & M. Crouch (Eds.), *Knowledge as value: Illumination through critical prisms* (pp.209-224). Amsterdam, Netherlands: Rodopi.

Newspaper article:
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R E S E A R C H	Open Access

The Impact of Hormonal Changes in Elderly Women: A Literature Review

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Abstract

As women age, hormonal changes become increasingly common and can significantly impact their overall health and well-being. In elderly women, these changes can lead to a range of physical and emotional symptoms that can greatly affect their quality of life. To further understand the health problems that arise from these hormonal changes, this study focused on menopause and andropause. The research methodology used in this study was a literature review. A total of 14 articles from PubMed, ScienceDirect, and PLOS One were reviewed, while established inclusion and exclusion criteria were taken into consideration. The findings suggest that a majority of postmenopausal women experience side effects from hormonal changes, including both physical and mental ailments. Menopause can also lead to sexual dysfunction, as well as an increased risk of osteoporosis, cardiovascular diseases, cancer, mental disorders, and chronic kidney disease. These changes can significantly impact an elderly individual's quality of life.

Keywords: Menopause, Elderly, Health Impact.

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1. INTRODUCTION

According to United Nations data, the number and proportion of people aged 60 years and over in the population is on the rise. In 2020, the number of people aged 60 and over reached 1 billion, and it is projected to increase to 1.4 billion in 2030 and 2.1 billion in 2050 (WHO, 2023). This increase in the number of elderly people will be especially rapid and unprecedented in developing countries over the next few decades.

The increase in life expectancy has caused the world's elderly population to grow rapidly, and every country is experiencing an increase in its elderly population (WHO, 2021). The consequences of the Aging Process are inevitable in human life span and health. Despite an increase in life expectancy, the trend of the elderly population is also growing rapidly and causing increasing morbidity and mortality rates associated with aging.

WHO categorizes elderly people into three groups based on age: early elderly aged 46-55 years, late elderly aged 56-65 years, and seniors aged 65 or older (WHO, 2021). The aging population has increased health issues among the elderly due to physiological and hormonal changes. As people age, various health problems arise due to physiological changes in all organ systems. Hormonal and metabolic changes associated with aging greatly contribute to major age-related chronic diseases, such as atherosclerosis, hypertension, diabetes, hyperlipidemia, obesity, sarcopenia, osteoporosis, thrombogenesis, chronic inflammation, and decreased immune function (Gusev & Sarapultsev, 2023; He et al., 2021; Rea et al., 2018). The decline in brain function is another health concern related to aging, which is mostly linked with the emergence of degenerative brain diseases and various types of dementia causing cognitive decline.

Aging adversely impacts not only hormonal secretion but also their biological availability (e.g., sex hormones) and their effects on targeted organs (e.g., insulin resistance). In addition, many metabolic changes, especially those related to hormonal actions, are related to lifestyle modifications that commonly occur with age. The effects of aging on the endocrine system affect hormone production, especially reproductive hormones. In elderly women, the production of the hormones estrogen and progesterone decreases, triggering menopause. Hormonal changes can also affect bone and muscle metabolism. Research shows that menopause in women marks musculoskeletal changes that worsen due to a lack of estrogen needed for bone and soft tissue remodeling (Amarya et al., 2018).

Despite numerous studies conducted on the hormonal and metabolic changes associated with aging in various countries, there remains a shortage of updated and comprehensive literature reviews. The purpose of this systematic review is to provide a comprehensive summary of the changes that occur with aging and explore ways to prevent or slow down these changes for the betterment of elderly women's well-being.

2. RESEARCH METHOD

The method used in this research is a literature review, namely a search for international and national literature using a database. The databases used to collect articles were PubMed, ScienceDirect, and PLOS One. The types of studies reviewed are all types of articles that use cross-sectional research methods whose contents analyze reproductive health problems caused by hormonal changes in the elderly, especially menopause and andropause. The inclusion criteria used were full-text open-access research articles published in 2017-2022 and originating from international English-language journals. The exclusion criteria used were research conducted not on humans, not a cross-sectional study, not discussing the influence of menopause and andropause, not being subscribed to by the University of Indonesia, and not discussing hormonal changes and their impacts. The keywords used in the article search were "menopause," "andropause," and "cross-sectional." The database used will be screened for keywords and inclusion criteria; all articles that do not match will be executed directly. In the

initial stage of searching for journal articles, 637 articles were obtained from the database from 2017 to 2022. Of this number, only 15 of them met the inclusion criteria for review.

3.   RESULTS AND DISCUSSION

We reviewed a total of 687 studies and collected 571 papers from PubMed, 8 from PLOS One, and 58 from Science databases. After eliminating non-English journals, we further screened 636 papers based on their relevance to our study's aims. By evaluating their titles, abstracts, and study designs, we selected 14 articles that discussed hormonal changes and their impact on elderly women (Figure 1). Most studies (38.5%) were conducted in India, and 76.9% were in Asian countries, such as India, Iran, Taiwan, Turkey, and China (Table 1).
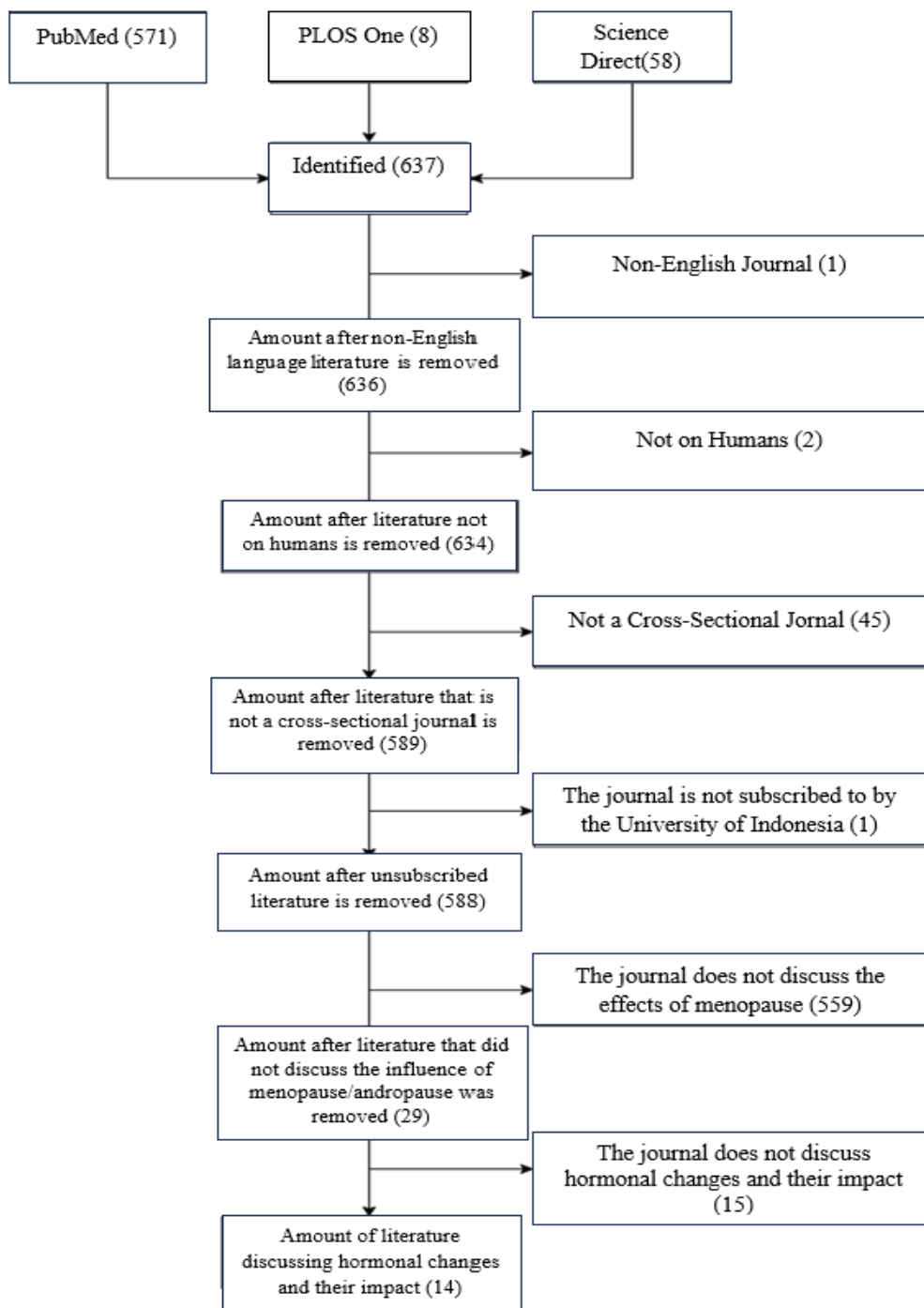
Figure 1. PRISMA Flow Chart of Study Selection

Table 1. The Summary of the Reviewed Articles

Title	Author, Year	Study Design	Country	Main Findings
Fracture risk in surgical and natural menopause	(Utkan Karasu et al., 2021)	Cross-sectional	Turkey	The study found that the risk of hip fracture was higher in natural menopause patients when bone mineral density (BMD) was taken into account (p=0.023). Lumbar vertebrae T-scores were similar between the two groups, regardless of age. However, femoral neck T-scores were higher in surgical menopause patients (T-score=-0.8) than in natural menopause patients (T-score=-1.25) under the age of 60. This difference disappeared after the age of 60.
Predictors of Osteoporosis and Osteopenia in Postmenopausal Women	(Khinda et al., 2022)	Cross-sectional	India	Higher systolic blood pressure (95%CI: 1.22-3.11 & 1.08-2.49), triglyceride levels (95%CI: 1.21-3.10 & 1.42-2.51), poor sleep quality (95%CI: 1.91-2.47 & 1.76-3.47), and C-reactive protein levels (95%CI: 2.18-3.56 & 1.03-2.18) were identified as independent variables influencing the risk of osteoporosis and osteopenia.
Impact Hormonal in Vulvovaginal Atrophy	(Palacios et al., 2019)	Cross-sectional	Spain	87.3% of patients had confirmed vulvovaginal atrophy (VVA). Among sexually active women (n=717), almost 80% reported pain during intercourse. Patients with confirmed VVA (n=1,028) were older (P<.0001), had lower rates of sexual activity (P<.05), and used more VVA treatments (P<.05) than patients without confirmed VVA (n=66).
High Circulating Follicle-Stimulating Hormone Level Is a Potential Risk Factor for Renal Dysfunction in Post-Menopausal Women	(Li et al., 2021)	Cross-sectional	China	A high level of follicle-stimulating hormone (FSH) is an independent risk factor for renal dysfunction in postmenopausal women. Aging may exacerbate the association between high FSH levels and reduced renal function.
Vital roles of age and metabolic syndrome-associated risk factors in sex-specific arterial	(Tsai et al., 2017)	Cross-sectional	Taiwan	Arterial stiffness increases more in women than men as they age, with 50 being the most

stiffness across nearly lifelong ages: Possible implication of menopause				critical factor across genders. Both menopause and andropause may play a role.
Impaired Quality of Life and Its Determinants among Postmenopausal	(Kumari et al., 2020)	Cross-sectional	India	Impaired QoL was associated with younger age (AOR: 4.6, 95% CI: 2.12–9.98), tobacco consumption (AOR: 2.0, 95% CI: 1.05–3.82), not being satisfied concerning husband (AOR: 3.33, 95% CI: 1.84–6.06), not having autonomy in health-care decision-making in the family (AOR: 2.30, 95% CI: 1.12–4.73), history of reproductive tract infection (AOR: 4.57, 95% CI: 1.71–12.19), and earlier onset of menopause (AOR: 3.26, 95% CI: 1.18–8.96)
Cardiovascular Risk in Menopause	(Abbas et al., 2018)	Cross-sectional	India	Women in surgical and natural menopause had significantly higher cfPWV and baPWV compared to those in the premenopausal group.
Quality of Life-Based on Psychological among Postmenopausal Women	(Krishnamoorthy et al., 2018)	cross-sectional	India	According to the study, 37.2% of the participants had poor quality of life (QOL) with a 95% confidence interval of 30.8% to 44.0%. The study found that individuals who belonged to the Hindu religion (annual percentage rate [aPR] -4.14), lived in nuclear families (aPR-2.31), had chronic comorbidities (aPR-5.52), and were alcohol/tobacco users (aPR-6.03) had a significantly higher risk of poor QOL.
Risk factors for sexual dysfunction among postmenopausal women:	(Tavoli et al., 2021)	Cross-sectional	Iran	Nearly half of women seeking gynecologic care experienced sexual dysfunction during menopause. Those with sexual dysfunction also reported higher rates of anxiety and depression.
The impact of menopause on sexual function in women	(Khalesi et al., 2020)	Cross-sectional	Iran	Out of 215 participants, 78 women (36.28%) reported female sexual dysfunction (FSD) and 37 men (17.2%) reported erectile dysfunction (ED). Among the men who reported ED, 18 (8.37%) had mild ED, 12 (5.58%) had mild to

				moderate ED, and 7 (3.25%) had moderate ED. In female participants, low scores on the subscales of the Female Sexual Function Index (FSFI) mostly impaired sexual satisfaction.
Psychological Status and Oxidative Stress in Postmenopausal Women	(Chandankhede et al., 2021)	Cross-sectional	India	Women experiencing depression, anxiety, and low self-esteem may face an oxidative challenge, which could be linked to a decrease in estrogen levels. Postmenopausal women with higher depression and anxiety scores tend to have lower levels of superoxide dismutase.
Menopause is a determinant of breast aromatase expression and its associations with BMI, inflammation, and systemic markers	(Brown et al., 2017)	Cross-sectional	USA	Postmenopausal women had higher BMI and more breast WAT than premenopausal women. Aromatase levels were higher in the breast tissue of postmenopausal women, with levels being higher in inflamed vs noninflamed, independent of BMI.
The relationship between menopausal symptoms and burnout	(Converso et al., 2019)	Cross-sectional & non-randomized	Spain	This study found that menopausal symptoms were significantly associated with emotional exhaustion. However, social or personal resources could not moderate this relationship. In terms of depersonalization, our study showed that it was only affected by menopausal symptoms among nurses who reported low social support from superiors and colleagues, as well as low levels of optimism and resilience.
Early-onset breast cancer with body mass index, menarche, and menopause in Taiwan	(Yang et al., 2022)	Cross-sectional	Taiwan	This study suggests that having a BMI less than 24 and being premenopausal are associated with an increased risk of early-onset breast cancer. There is a positive interaction on an additive scale.

As age progresses, there is a transition from adulthood to old age, all physiological functions begin to decline gradually. Changes in almost all biological systems characterize the aging process. Major changes occur in the endocrine system, but there are other factors that influence the aging process, such as inflammation and calorie intake, which are also related to age-related chronic diseases.

The endocrine system undergoes major changes during old age, and the pattern of hormone secretion produced by the hypothalamic-pituitary axis changes, as well as its sensitivity to negative feedback from end hormones. Triggers that determine the aging process in the hypothalamus and pituitary.

In elderly women, Menopause is an inevitable physiological process that refers to the time when menstrual periods stop permanently. Fluctuations and deficiencies in hormone levels during post-menopause can cause changes in women's sexual function (Khalesi et al., 2020). Menopausal women experience a decrease in estrogen levels, causing changes in the psychology, histology, and anatomy of the urogenital area (Palacios et al., 2019). In general, hormonal changes in the elderly affect their physical, sexual, and psychological conditions and quality of life.

a.   Physical Changes

As we age, anatomical and physiological changes occur, age-related changes occur. Based on the cross-sectional study in the journal above, it was found that in the range between the ages of 40 and 66 years, there was an increase in body weight in the elderly on average of 0.3 to 0.5 kg per year and then remained stable or even continued to increase until the age of 70 years. However, several other longitudinal studies show that there is a decrease in body weight (not exceeding 0.3% per year) in elderly men and women after the age of 60 years. Changes in body weight show an increase in body fat and a decrease in lean tissue. Body fat increases by an average of 1% per year in both men and women from the age of 40, and loss of lean tissue occurs in skeletal muscle and organs such as the liver (Krishnamoorthy et al., 2018). This change in body composition results in changes in metabolic function because lean tissue is the main determinant of energy needs. A gradual and progressive decrease in hormone production and action has a negative impact on human health by increasing the risk of chronic diseases. The impact of hormonal changes on various chronic conditions can result in several diseases, such as diabetes, cardiovascular disease, and dementia.

Elderly women experience physical changes caused by hormonal changes. Various age-related hormonal and metabolic changes greatly contribute to major age-related chronic diseases and decreased physiological function, including atherosclerosis, diabetes, hypertension, hyperlipidemia, obesity, sarcopenia, osteoporosis, thrombogenesis, chronic inflammation, and decreased immune function. In this study, physical changes that are highly prevalent in the elderly are discussed, namely cardiovascular diseases (CVD), osteoporosis, kidney disorders, and an increased risk of breast cancer.

b.   Cardiovascular

Cardiovascular disease (CVD) is a group of heart and blood vessel disorders consisting of coronary heart disease and cerebrovascular disease. peripheral arterial disease, rheumatic heart disease, congenital heart disease, deep vein thrombosis, and pulmonary embolism (WHO, 2021). Risk factors for cardiovascular disease are unhealthy diet, lack of physical activity, tobacco consumption, and harmful alcohol use. Apart from that, menopause also has the potential to be related to cardiovascular events. Menopause strengthens the relationship between C-reactive protein and pulse wave velocity (PWV) regardless of age. There is a chance

that menopause is associated with increased inflammation, leading to increased blood vessel stiffness and cardiovascular risk (Woodard et al., 2011) .

It was found that the group of women with natural menopause had significantly higher systolic and diastolic blood pressure compared with the premenopausal and surgical menopause groups. Additionally, it was found that cfPWV and baPWV were found to be significantly higher in the natural menopause and surgical menopause groups when compared with the premenopause group (Abbas et al., 2018). However, women with surgical menopause have greater arterial stiffness, likely resulting from the physiologic effects of hysterectomy on arterial health. In women, increased arterial stiffness appears to increase after menopause, most likely due to estrogen deficiency. Estrogen deficiency causes a decrease in the protection of various systems/organs in a woman's body (Sugiritama & Adiputra, 2019). Research conducted by Tsai et al. (2017) showed a similar thing: after the age of 50, the baPWV ratio in men and women increased by 2.4 times (Tsai et al., 2017). In both women and men, significant increases in arterial stiffness were only found at ages associated with menopause and andropause.

c.   Osteoporosis (physical)

Menopause is a natural biological process that marks the end of the menstrual cycle and usually occurs in women between 45 and 55 years old. A woman is considered to have reached menopause if she has not had a menstrual period for at least 12 consecutive months. During menopause, estrogen hormone levels decrease while follicle-stimulating hormone (FSH) levels increase, resulting in the thinning of ovarian follicles. Surgical menopause occurs when both ovaries are surgically removed, leading to menopause (Rodriguez & Shoupe, 2015). The ovaries function as estrogen producers, inhibiting bone resorption to prevent osteoporosis (Parker, 2014). Based on a study by Rodriguez et al., menopause can cause bone loss during the pre-menopausal period. Bone loss occurs more rapidly in patients who undergo oophorectomy at an early age before natural menopause, but oophorectomy after natural menopause does not affect bone density (Rodriguez & Shoupe, 2015). Other research states that the severity of osteoporosis and the risk of bone fractures in menopause occurs when women enter menopause naturally (Utkan Karasu et al., 2021).

Several risk factors contribute to the incidence of osteoporosis in the elderly, as shown in research conducted in Punjab, India. These risk factors include low body mass index, high systolic blood pressure, C-reactive protein (CRP), and Triglycerides, and lack of sleep (Khinda et al., 2022). There is a strong correlation between a higher lipid profile, especially triglycerides, with impaired bone mass, weak bone mineral metabolism, and increased fractures (Sivas et al., 2009). It has been clarified through meta-analysis that hypertension is associated with bone loss and a higher risk of fracture. In addition, hypertension has been implicated in severe loss of bone minerals, including calcium, and its metabolism results in accelerated bone resorption (Strazzullo et al., 1983). Not only that, poor quality and quantity of sleep can affect bone health by causing deformities and reducing the ability of bones to heal from fractures (Luyster et al., 2012). Besides that, high levels of CRP as a marker of inflammation are the strongest risk factor for osteoporosis because they reduce bone mass density in pre- and postmenopausal women (Khinda et al., 2022).

d.   Kidney Disorders

The kidneys are one of the important organs in the body and function to maintain environmental stability in the body (Rivandi, 2015). As age increases, kidney function decreases, which is characterized by a decrease in GFR (Glomerular Filtration Rate) (Li et al., 2017). Another factor that influences the decline in kidney function is menopausal status, where hormonal changes occur in the body during the pre-menopausal and post-menopausal stages.

When women experience menopause, the production of the hormone estrogen decreases; in menopause, this hormone has a role in protecting the function of a person's kidneys so that when the production of the hormone estrogen decreases, the risk of developing chronic kidney disease increases (Li et al., 2021). This is supported by the results of other studies, which state that women who have experienced menopause are at greater risk of developing chronic kidney disease due to decreased levels of the hormone estrogen (Horstman et al., 2012). In contrast to the decrease in estrogen hormone levels in post-menopausal women, FSH (Follicle-stimulating hormone) levels increase. Along with the increase in FSH, serum creatinine also increases (Li et al., 2021).

FSH is a gonadotropin hormone released by the pituitary gland and distributed through the bloodstream (Onizuka et al., 2019). In line with research conducted by Qihang (Qihang, 2017), FSH levels in research conducted on pre-menopausal and postmenopausal women in Tokyo, Japan showed similar results. These results are that in pre-menopausal women, FSH levels in urine tend to be low when compared to E1 and E2 (Estrogen, which acts as an indicator in menopausal women), while in post-menopausal women FSH levels increase and E1 and E2 decrease (Onizuka et al., 2019). Increased creatinine caused by increased FSH causes glomerular filtration function to decrease, and this can cause the risk of developing chronic kidney disease to be 2-10 times greater when compared to women who have low FSH levels (Li et al., 2021).

e. Breast cancer

Menopause is associated with significant changes in hormone levels, which contribute to physical and biological consequences that impact the occurrence of several diseases. Menopausal status is often associated with an increased risk of cancer. Some reproductive cancers, especially breast cancer, are more common in women after menopause. Despite low circulating estrogen levels, most breast cancers occurring after menopause are estrogen-dependent, and the risk of breast cancer in these women increases with obesity and metabolic syndrome (Brown et al., 2017).

Aromatase is the enzyme that catalyzes the final and key step in estrogen biosynthesis. Given the low concentrations of circulating estrogen after menopause, it is scientifically suspected that estrogen originating from the breast is the primary driver of breast cancer growth and tumors that have the capacity to increase further local estrogen production, which was ultimately proven by reports that the highest levels and activity of aromatase are found in breasts containing tumors. Studies in mice and women have shown that increased body weight or body mass index (BMI), as well as associated white adipose tissue inflammation (WATi), is positively correlated with aromatase in breast tissue (Brown et al., 2017).

The results of a study conducted by Brown et al. (2017) highlighted the potential importance of locally produced estrogen in the development of breast cancer after menopause, showing that pre-and postmenopausal women, the majority, develop estrogen receptor-positive breast cancer. In addition, the study results also showed that across the BMI range, postmenopausal women had higher breast aromatase expression than premenopausal women. This research also shows that certain obesity-related parameters are more strongly associated with increased aromatase after menopause, which is a risk factor for breast cancer. A similar study was conducted by Yang et al. (2022), who showed that premenopausal status accounted for 60.3% of early-onset cases and increased the risk 4.59-fold of early-onset breast cancer (Yang et al., 2022). Furthermore, whether BMI status is < 24 or premenopause, the risk of early breast cancer is more significant, with a risk of 7.16 times. It is also stated that being overweight or obese in adulthood in women is associated with an increased risk of postmenopausal breast cancer, colorectal cancer, kidney cancer, liver cancer, and pancreatic cancer (Yang et al., 2022).

Although this research has some limitations, such as the use of a literature review study design and a cross-sectional study design for journal review results, it provides a comprehensive discussion of the health impacts on the elderly due to hormonal changes during the pre-menopausal and post-menopausal periods. Despite the limited literature available, the research findings are significant and provide valuable insights into this important topic.

f. Sexual dysfunction

Menopause can affect sexual function due to changes in sensory perception, central and peripheral nerves, peripheral blood flow, and muscle tension capacity in response to estrogen deficiency (Tavoli et al., 2021). The consequences of decreased estrogen due to menopause, such as urogenital atrophy, vaginal dryness, and decreased tissue elasticity, can result in dyspareunia and affect sexual behavior in women (Khalesi et al., 2020).

Female Sexual Dysfunction (FSD) or female sexual dysfunction is a condition that affects many women throughout the world. Sexual dysfunction is a group of symptoms, including sexual interest and arousal, orgasm, and low sexual satisfaction, as well as pain that leads to sexual dysfunction among women. Problems in sexual desire, lubrication, as well as dyspareunia are the most commonly reported sexual dysfunctions among postmenopausal women (Tavoli et al., 2021). About more than half of menopausal women experience low sexual desire (Khalesi et al., 2020). Several factors influence sexual function in postmenopausal women, including age and mental health.

The transition from reproductive age to menopausal status may further exacerbate sexual dysfunction, while the impact on mental health is somewhat more complex (Tavoli et al., 2021). The complex relationship between psychological factors, such as anxiety and depression, and sexual dysfunction can be explained by the fact that post-menopausal women experience lower self-esteem and body image, both of which lead to reduced sexual desire (Tavoli et al., 2021). Some women feel less sexually attractive because they tend to gain weight due to a slow metabolism. This problem also contributes to anxiety and depression, leading to reduced sexual function (Tavoli et al., 2021). However, poor sexual function due to hormonal and physiological changes in postmenopausal women can cause anxiety and depression. Thus, there is a cyclical pathway between psychological factors and sexual dysfunction in women experiencing menopause.

Menopause is not only a difficult time for women, but it is also difficult for their partners. In general, women's sexual problems after menopause play an important role in determining a couple's sexual function. Post-menopausal women who suffer from sexual dysfunction tend to avoid sexual intercourse to reduce vaginal burning during sexual intercourse. Attitudes and feelings towards sex, faced with the reality of aging and menopause symptoms in female partners, also influence sexual life (Khalesi et al., 2020).

Apart from FSD, postmenopausal women also experience other disorders caused by a decrease in estrogen, one of which is physical changes in the form of vaginal atrophy (Goldstein et al., 2013). Vulvovaginal atrophy is a condition where the lining of the vagina becomes thin and dry; this is caused by a decrease in estrogen levels, with estrogen playing a role in maintaining moisture and thickness of the urogenital area (Palacios et al., 2019). Apart from the reduced humidity and thickness of the urogenital area due to decreased estrogen levels, the elasticity and blood flow to this area are also reduced compared to women who have not experienced menopause (Palacios et al., 2019).

Symptoms that are often felt by postmenopausal women with vulvovaginal atrophy are vaginal dryness, pain during intercourse, bleeding before or after intercourse, itching or burning in the urogenital area, dysuria, and abdominal pain (Palacios et al., 2019). Apart from that, another symptom felt by post-menopausal women who experience vulvovaginal atrophy is a

loss of desire for sexual activity (Parish et al., 2013). The emergence of symptoms of vulvovaginal atrophy in postmenopausal women causes disturbances in sexual function, where sexual function disorders are twice as large as those found in postmenopausal women with confirmed vulvovaginal atrophy (Palacios et al., 2019). In line with research conducted by Palacios in Spain regarding the prevalence of vulvovaginal atrophy, a previous study revealed that 51% of women in the United States who experience post-menopause experience symptoms of vulvovaginal atrophy (Parish et al., 2013).

Apart from having an impact on changes in sexual function, hormonal changes also have an impact on other aspects of health, such as osteoporosis, kidney problems, decreased quality of life, cardiovascular disease, and psychological disorders (Cheng et al., 2022; Wang et al., 2023).

g.   Quality of Life

Quality of Life (QOL) is an individual's perception of their position in life in the context of the cultural and value systems they live by and their relationship to their respective goals, expectations, standards, and concerns (Teoli & Bhardwaj, 2023; WHO, 2012). The Menopause-Specific Quality of Life Questionnaire (MENQOL) is used specifically for menopausal women. This questionnaire is used as a tool to measure certain symptoms during menopause, such as disturbances in emotional, physical, and social aspects of a person's life (Radtke et al., 2011). Various symptoms that arise due to menopause can affect a person's quality of life or QOL— starting from impacts in the form of vasomotor, psychological, physical, and urogenital (Kumari et al., 2020).

In several areas in India, both urban, rural, and slum areas, descriptive cross-sectional research has been carried out to see the impact of menopause on QOL. It was found that menopause impacts QOL (Kaur Kang et al., 2021; Krishnamoorthy et al., 2018; Kumari et al., 2020). The difference is only in prevalence. In urban areas, more than a third of postmenopausal women have poor QOL due to the effects of menopause. Most suffer from psychological problems, followed by some vegetative problems and urogenital problems (Krishnamoorthy et al., 2018). In rural areas, the same thing is found, namely that QOL decreases in women who experience menopausal symptoms, and this has an impact on their physical, mental, and social well-being (Kaur Kang et al., 2021). Finally, in slum areas, it was found that more than ⅔ of menopausal women experienced a decline in QOL due to the symptoms they experienced (Kumari et al., 2020). The most common impact is discomfort in the joints and muscles. Next, hot flashes, irritability, and physical and mental fatigue follow. From these three studies, it can be concluded that menopause has an impact on QOL. Menopausal symptoms experienced by elderly women cause QOL to decrease. However, each region has different severity and prevalence.

h.   Psychological

Menopause is a process that causes changes in women's physical, psychological, and cognitive aspects (Nelson, 2018). According to studies, the symptoms of psychological changes that arise during menopause are caused by hormonal changes. Socio-cultural factors related to perceptions about menopause and individual personality factors also influence psychology. The symptoms of psychological changes experienced can differ for each individual; some may not feel any changes. This follows the results of research by Manju et al. (2021), which states that not all post-menopausal women experience high levels of anxiety, low self-esteem, and depression (Chandankhede et al., 2021). However, research conducted by Manju et al. (2021) and Jafari et al. (2014) found that post-menopausal women experienced higher levels of anxiety and depression scores as well as lower levels of mental health, quality of life, and enthusiasm.

A woman can experience psychological stress due to menopause, but of course, psychological instability, depression, and anxiety are not caused by menopausal status alone (Chandankhede et al., 2021). Research conducted by Daniela et al. (2019) on nurses working in two Italian public hospitals included social (e.g., support from superiors and colleagues) and personal factors (such as confidence in one's own abilities, resilience, and optimism) as influencing factors in the appearance of menopausal symptoms (Converso et al., 2019). Apart from that, the research also obtained results that menopausal symptoms were positively related to emotional exhaustion, which is a component of burnout.

4.   CONCLUSION

As we age, our physiological function gradually declines. This aging process leads to changes in almost all biological systems, with major changes occurring in the endocrine system. These changes impact the health of elderly women, especially when they enter menopause. Menopause can lead to Female Sexual Dysfunction (FSD), an increased risk of non-communicable diseases such as coronary heart disease, a decreased Quality of Life, an increased risk of cancer, an increased risk of psychological disorders, and chronic kidney disease caused by increasing FSH levels and decreasing estrogen levels with age. However, positive lifestyle modifications such as physical activity and a balanced diet can have a positive effect on endocrine function and metabolism. These modifications can also act as a countermeasure against various age-related diseases. The results of this research can aid in educating the public about hormonal changes that not only cause menopause but also result in various other health impacts.

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R E S E A R C H   **Open Access**

The Relationship between Drinking Coffee and Hypertension in Several Countries: Systematic Review and Meta-Analysis

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Abstract
Coffee is the most consumed drink in the world and has the highest caffeine content. Caffeine in coffee has an effect on hypertension, which is a leading cause of death throughout the world. However, the long-term effect of drinking coffee on the risk of hypertension is still controversial. This study aimed to determine the relationship between drinking coffee and the risk of hypertension through a meta-analysis study of several cross-sectional survey studies using the search engines PubMed, Science Direct, Proques, and Scopus. Search results via search engines found 3 relevant articles for analysis. A significant association was found between drinking coffee and hypertension with a combined risk of 1.58 (95% CI: 1.46, 1.72). Lifestyle changes through regulating coffee drinking patterns can be one of the government and stakeholder programs as primary prevention of hypertension among adults, especially since drinking coffee is currently very popular.

Keywords: Coffee, Hypertension, Systematic Review, Meta-Analysis.

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1.   INTRODUCTION

Caffeinated drinks are among today's most widely consumed and popular drinks (Doepker et al., 2022). It is estimated that approximately 85% of Americans consume caffeine daily with an average intake of 135 mg. Coffee has the highest caffeine content among drinks containing caffeine (van Dam et al., 2020). It is estimated that global consumption of coffee reaches 500 billion cups per year, and more than 150 million bags (60 kg) of coffee were consumed in 2016 (Butt & Sultan, 2011). This widespread coffee consumption has resulted in more and more researchers focusing on the impact of coffee consumption on health (van Dam et al., 2020).

Caffeine affects the cardiovascular, respiratory, gastrointestinal, and kidney systems (Barcelos et al., 2020; Chen et al., 2022; Hu et al., 2018; Iriondo-Dehond et al., 2021). This also influences hypertension by increasing systolic and diastolic blood pressure (Cappelletti et al., 2015). Caffeine can increase blood pressure by blocking adenosine receptors in blood vessels and by causing vasoconstriction (Han et al., 2022; Umemura et al., 2006).

Hypertension is the strongest predictor of mortality in both high- and low-income countries (Lopez et al., 2006; Mills et al., 2020; Zhou et al., 2021). Around 1.39 billion adults worldwide suffer from hypertension with a prevalence reaching 28% in high-income countries (D'Elia et al., 2019). It is estimated that there will be an increase in the prevalence of hypertension worldwide by 30% by 2025 (Kearney et al., 2005). Based on this, preventing an increase in the prevalence of hypertension can be prevented at least by controlling coffee consumption (Zhang et al., 2011).

As early as the 1930s, it was recognized that coffee consumption was a potential risk factor for blood pressure due to the acute pressure effect of caffeine (Miranda et al., 2021). However, the long-term effect of coffee drinking on the risk of hypertension was still controversial in several randomized controlled trials and cohort studies (Xie et al., 2018). Recent studies have also shown that coffee consumption habits in healthy groups were not associated with an increased risk of hypertension (95% CI: 0,61 - 1.52) (O'Keefe et al., 2013).

The results of the dose-response meta-analysis from research conducted by D'Elia, et al (2019) also show the same thing, the habit of moderate coffee consumption is not related to the risk of hypertension in the general population and there is a non-linear inverse dose-response relationship that occurs between coffee consumption and the risk of hypertension (Q=5.98, p=0.20, I2=33%) (D'Elia et al., 2019). However, no meta-analysis studies have been conducted generally on large cross-sectional survey population groups.

The differences in definitions of coffee exposure between studies mean that the relationship between coffee consumption and hypertension risk cannot be analyzed precisely(Poole et al., 2017; Wong et al., 2021). Moreover, there are no meta-analysis studies regarding coffee drinking and hypertension in large populations through surveys with cross-sectional studies. Therefore, this study aims to determine the relationship between drinking coffee and the risk of hypertension using a meta-analysis study of several recently published cross-sectional survey studies.

2.   RESEARCH METHOD

This meta-analysis was designed, analyzed, and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Ahn & Kang, 2018). A systematic search was done by identifying relevant journals on the search engines PubMed, ScienceDirect, Proquest, and Scopus using the search words "coffee", "caffeine", "hypertension", and "blood pressure". The journal search was limited to publications from 2018 to 2023.

Independent reviewers screened titles and abstracts for eligible articles. Disagreements were resolved by discussion. Then, based on the full text of the identified articles, their eligibility for inclusion was assessed according to our inclusion and exclusion criteria. Studies were included if they met the following criteria: 1) a population-based cross-sectional study of people with hypertension and 2) an adult group population (≥ 15 years).

Furthermore, the exclusion criteria were articles that did not provide clear results and explanations regarding the research topic and did not have risk values and a clear group distribution table for the incidence of hypertension and coffee drinking. The categorization of the coffee-drinking variable was measured based on the coffee drinking of the 24 before the research was conducted.

3. RESULTS AND DISCUSSION

A total of 1,782 articles were identified through Pubmed (154), Proquest (730), ScienceDirect (532), and Scopus (366) search engines based on search terms and inclusion criteria. However, 1,737 articles were excluded after reviewing the titles, articles with full text, and duplicate titles and authors, so 35 articles were found that were relevant for analysis. Next, article exclusion was carried out based on the irrelevant title and abstract assessment of 26 articles, so 9 articles were suitable for analysis. Finally, 3 articles were found relevant for analysis, met the criteria, and could be accepted after excluding 3 articles through full-text review (figure 1).

Table 1. The Characteristics of Studied Subjects

Researchers	Title	Location	Sample	OR	Variables controlled are based on Multivariate analysis
Shah et al., (2023)	Coffee intake and hypertension in Korean adults: results from KNHANES 2012–2016	Korea	KNHANES 2012–2016, which included 12.133 participants (19 years or older)	0,84 (0,73-0,99)	Age, gender, education, body mass index (BMI), current smoking, heavy drinking, diabetes, and hypercholesterolemia, energy intake, income, and region of residence.
Fan et al., (2023)	Coffee consumption and abdominal aortic calcification among adults with and without hypertension, diabetes, and cardiovascular diseases	United States	2.548 participants data from the National Health and Nutrition Examination Survey (NHANES)	0.72 (0.21-1.22)	Age, gender, race, education level, marital status.
Sathi et al., (2022)	Prevalence, trends and associated factors of hypertension and diabetes mellitus in Bangladesh: Evidence from BHDS 2011 and 2017–2018	Bangladesh	11,686 adults as a study sample for the analysis	1,06 (0,95-1,17)	Age, education, occupation, residence, and wealth status.
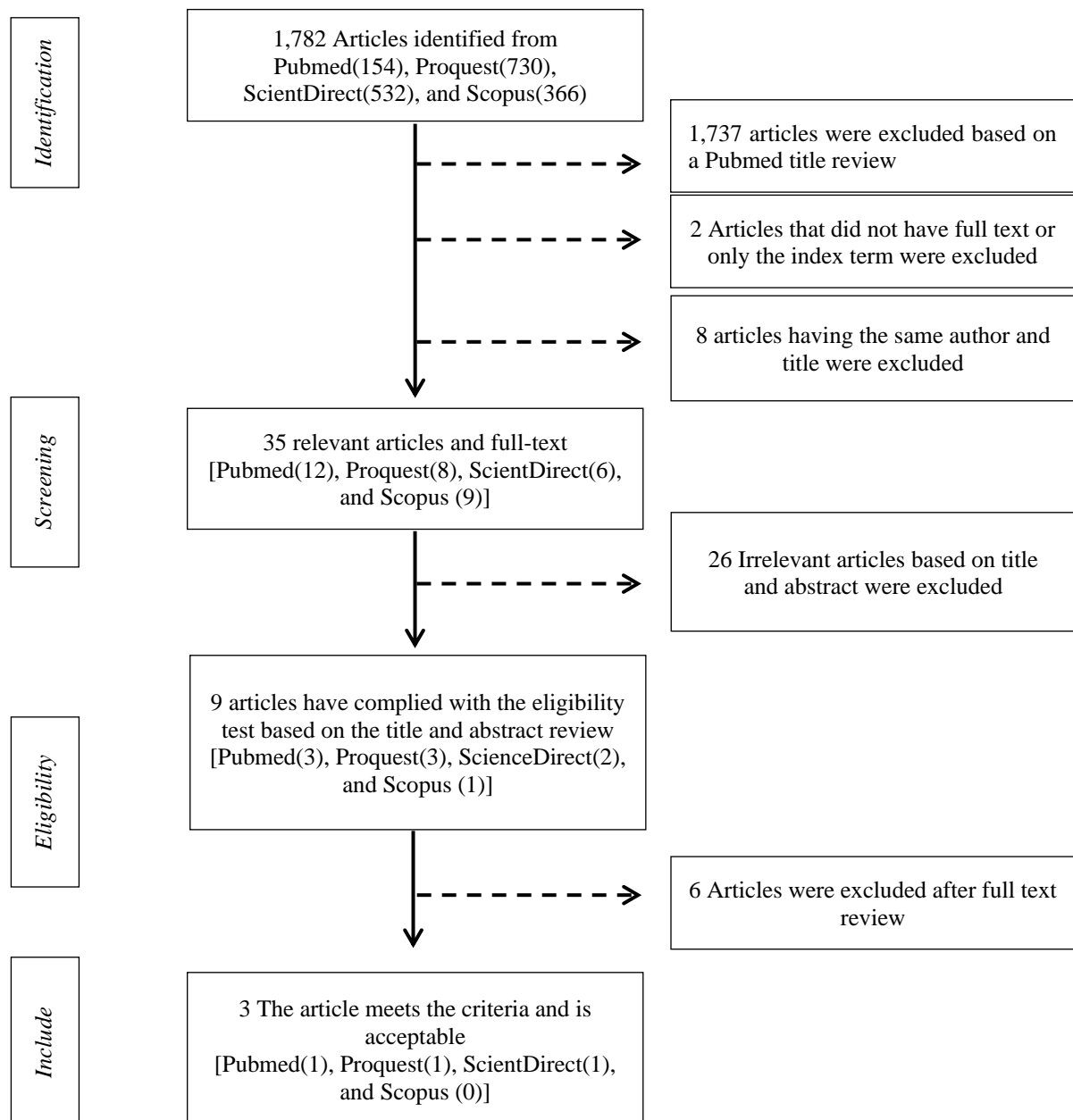
Figure 1. Flowchart of Relevant Articles on the Relationship between Coffee and Hypertension in Several Countries.

Article analysis was carried out on 3 articles which were found to include several countries, including Korea (2023), the United States (2023), and Bangladesh (2022). The research is carried out on large populations or communities through surveys. All studies generally control confounding variables such as age, gender, education, and employment, on the relationship between coffee drinking and the incidence of hypertension. Research from Surahi Shah, et al (2023) shows that there is a protective relationship between drinking coffee and hypertension (OR: 0.84, 95% CI: 0.73-0.99) (Shah et al., 2023). However, research from Haze Fen, et al (2023) and Nusrat, et al (2022) shows that there is no significant relationship

between drinking coffee and hypertension (OR: 0.72, 95% CI: 0.21-1.22 and OR: 1 .06, 95% CI: 0.95 - 1.17) (table 1) (Fan et al., 2023; Sathi et al., 2022).

Study or Subgroup	Yes Events	Total	No Events	Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Haze Fen 2023	834	1550	548	998	36.5%	0.96 [0.82, 1.12]
Nusrat 2022	230	739	3136	10947	32.4%	1.13 [0.96, 1.32]
Surahi Shah 2023	535	1239	1824	8535	31.1%	2.80 [2.47, 3.16]
Total (95% CI)		3528		20480	100.0%	1.58 [1.46, 1.72]
Total events	1599		5508			

Heterogeneity: Chi² = 136.58, df = 2 (P < 0.00001); I² = 99%
Test for overall effect: Z = 10.85 (P < 0.00001)
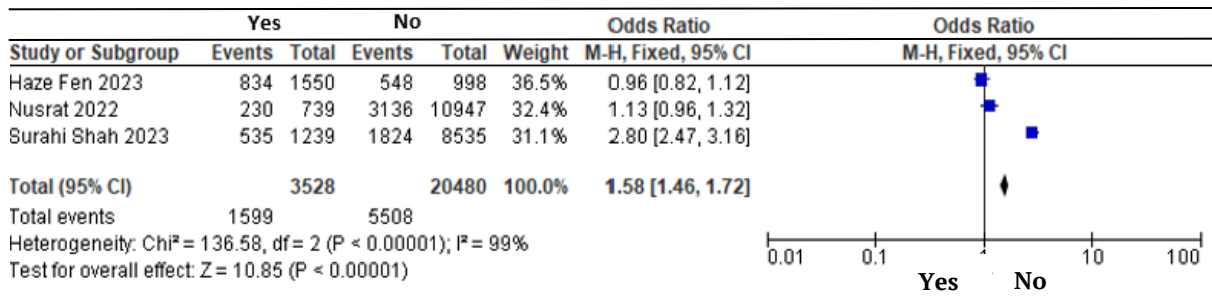
Figure 2. Forest Plot Meta-Analysis of the Relationship Between Drinking Coffee and Hypertension

A meta-analysis of the relationship between coffee drinking and hypertension was carried out on 3 articles. Forest plot meta-analysis shows a significant relationship between drinking coffee and the incidence of hypertension, with an odds ratio of 1.58 (95% CI: 1.46 - 1.72). This explains that adults who drink coffee have a 1.58 times higher risk of developing hypertension compared to adults who do not drink coffee. This is in line with research from Nusrat, et al (2022), which found that respondents who drank coffee had a higher risk of developing hypertension compared to respondents who did not drink coffee (OR: 1.06) (Sathi et al., 2022).

Analysis from several countries shows that an increase in the prevalence of hypertension accompanies high coffee consumption. The caffeine in coffee can stimulate the production of adrenaline which has effects on the cardiovascular system, such as increased blood pressure, endothelial dysfunction, inflammation, and decreased sensitivity to insulin, which may be associated with the risk of cardiovascular disease (Paiva C et al., 2019; Rodak et al., 2021; Rodríguez-Artalejo & López-García, 2018). Therefore, lifestyle changes through regulating coffee drinking patterns can become a program for the government and stakeholders as a primary preventative for hypertension among adults, especially since drinking coffee is currently very popular (Haghighatdoost et al., 2023).

The study from Haze Fan et al (2023) analyzed in this meta-analysis explains that the individual coffee intake variable was obtained from a 24-hour food recall interview, which allows for recall bias (Fan et al., 2023). However, Asghar Z. Naqvi argues that asking again about food consumption in the previous 24 hours can provide enormous benefits to credible estimates (Naqvi et al., 2014). Thus, when using 24-hour food recall to assess dietary intake, including coffee consumption, it is important to conduct it continuously to ensure consistency in respondent answers.

The main strengths of this meta-analysis are the collection of studies from a large population from different countries and ethnicities with a wide age range, a comprehensive literature search to identify relevant articles, and an analysis based on multiple confounding factors. This study's systematic review and meta-analysis analysis show the relationship between coffee drinking and hypertension in several countries. It provides the latest information for the last 5 years on adult groups in populations and communities, including 3 cross-sectional studies. However, a relatively high statistical heterogeneity value was found in this study. This could be because searching for journal articles via search engines allows skipping articles that are not published, thus impacting publication bias.

4. CONCLUSION

The results of a systematic review and meta-analysis of this research show a significant relationship between drinking coffee and the risk of hypertension in the adult group. Lifestyle changes through regulating coffee drinking patterns can be one of the government and stakeholder programs as a primary preventive strategy for the incidence of hypertension among adults, especially since drinking coffee is currently very popular. Furthermore, to identify deeper and more specific prevention programs in Indonesia, further research is needed through surveys of coffee-drinking communities and their relationship with hypertension in the adult population in Indonesia.

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R E S E A R C H　　　　　　　　　　　　　　　**Open Access**

Effectiveness of Bay Leaves (*Syzygium polyanthum*) to Reduce Body Mass Index Among Pre-Menopausal Obese Adults in South Jakarta Regency

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Abstract
Perimenopause is a transition phase towards menopause which is characterized by hormonal changes, including a decrease in the production of the hormone estrogen and an increase in belly fat which can cause obesity. This study aimed to examine the effectiveness of bay leaves to reduce body mass index (BMI). The research design used was quasi-experimental with a one-group pretest and posttest-only design. The population in this study were pre-menopausal adults with obesity who were selected using purposive sampling with a total respondents 30 adults. During 14 days, they are given the 4-5 bay leaves which were previously boiled with around 250 ml water. The BMI was calculated before and after giving the intervention. Data analysis used the Wilcoxon analysis test. The results revealed that there are significantly reduced BMI compared to before and after the intervention. The content of bay leaves can accelerate weight loss in pre-menopause because it has a thermogenic effect on the body and can be used as an alternative herbal therapy that is very easy to obtain and economical which can be used by obese women in perimenopause. The health promotion to introduce bay leaves could be started as bay leaves are easy to find and grow.

Keywords: Bay Leaves, Salam, Obesity, Pre-Menopausal, Adult.

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1. INTRODUCTION

Obesity among pre-menopausal adult women is common due to unbalanced hormones and an increase the belly fat. Previous studies have highlighted the impact of obesity on gut microbiota composition, functionality, and gonadal steroid status in pre-menopausal women, indicating that obesity can eliminate differences observed among non-obese pre-menopausal women, post-menopausal women, and men (Mayneris-Perxachs et al., 2020). The association between obesity and sleep-disordered breathing has been emphasized, particularly in pre-menopausal women, suggesting a strong impact of obesity in this population (Matsumoto et al., 2020). The impact of being obese during the pre-menopausal period is important to prevent. Existing studies have explored the relationship between obesity, weight gain, and breast cancer risk in pre-menopausal women, indicating that adult weight gain may increase post-menopausal breast cancer risk among women with lower body mass index at a younger age (Renehan et al., 2020). Dietary factors have also been studied, with findings showing that higher fruit and vegetable intake is associated with a lower risk of central obesity among pre-menopausal women (Su et al., 2022). Structural equation model analysis has revealed significant differences in body fat percentage and visceral fat area between menopausal and pre/perimenopausal women, highlighting the impact of menopausal status on obesity-related factors (Darbandi et al., 2019). Studies have highlighted the paradoxical relationship between obesity and breast cancer risk in pre-menopausal women, where obesity appears to be protective in this population (García-Estévez et al., 2021). However, the integrative effects of modifiable risk factors, including obesity, on menstrual cycle irregularity and menopause, remain incompletely understood (Bae et al., 2018). Additionally, obesity has been associated with alterations in age at natural menopause, with a higher risk of early menopause observed among obese women (Zhu et al., 2018).

The role of obesity in influencing adipose tissue milieu and its association with increased mortality risk, particularly central obesity, independent of BMI, underscores the significant impact of obesity on health outcomes (Bracht et al., 2019). The association between obesity and heart failure, as well as the differential risk patterns observed in pre-menopausal and post-menopausal women, highlights the nuanced relationship between obesity and cardiovascular health (Leedy et al., 2021). Obesity has been linked to low-grade inflammation, leucocytosis, and an increased risk of venous thromboembolism, emphasizing the broader health implications of obesity (Christakoudi et al., 2023).

There is evidence that being obese among pre-menopausal age is a high risk for non-communicable diseases and mortality. While obesity may have protective effects in certain contexts, such as breast cancer risk in pre-menopausal women, it remains a critical risk factor for various health conditions and mortality outcomes. There are some herbs to reduce body weight. It revealed several studies have explored the potential of herbal remedies. There is green tea, taraxacum officinale, guarana, and Irvingia gabonensis. However, there is a lack of studies to test the effectiveness of bay leaves in reducing body weight. Bay leaves have been studied for reducing blood pressure, gut, and cholesterol but limited study on their effect on reducing body weight. This study aimed to test the effectiveness of bay leaves in reducing body weight among pre-menopausal obese adults in South Jakarta.

2. RESEARCH METHOD

The current study used a quasi-experimental design to examine the effectiveness of bay leaves to reduce body mass index. The data collection was conducted in Posyandu (Integrated Healthcare Center) Anggrek, East Cilandak, South Jakarta, Indonesia. The data has been collected in January 2024.

The sample in this study needs to meet the criteria of pre-menopause adults aged 40 to 60 years old, obese and did not consume the obesity drug. The exclusion criteria in this study include the respondents with an unwillingness to join the whole interview and receive intervention. The population of the study consists of 45 adults, but the sample in this study was 30 who were selected using purposive sampling.

In this study, there is one group only. The intervention was given to the case group to observe the effectiveness of the intervention given. The intervention was given a decoction of bay leaves. The bay leaves were given about 4 to 5 leaves and boiled with 240 ml water. It was given for a once-a-day dose in the morning for 14 days. Before and after the given intervention, all the respondents were measured for height and weight to calculate body mass index (BMI). Body Mass Index in this study was calculated by the formula of weight in kg divided by height in meter square (kg/m2). The IMT in this study was used in the category by the Ministry of Health Indonesia.

The Wilcoxon test analyzed the data to examine the correlation between the independent variable and the dependent variable. The analysis was done by using SPSS software for Windows. The preliminary test and normality test were done using Shapiro-Wilk. The bivariate analysis in this study to test the hypothesis was done using paired t-test and t-test dependent.

This study including instruments and tools has been approved by the Ethical Committee University of Muhammadiyah Purwokerto with reference number: KEPK/UMP/43/II/2024.

3. RESULTS AND DISCUSSION

The results in this study consist of univariate and bivariate analyses. Table 1 below describes the general characteristics of the respondents. Among all respondents in this study (n = 30), the majority of them were female (70%), working (60%), and attended from senior high school (56.7%).

Table 1. The general characteristics of the sample (n = 30).

Characteristics	Frequency	Percentage
Sex		
Male	9	30
Female	21	70
Working status		
No	12	40
Yes	18	60
Educational level		
Uneducated	1	3.3
Elementary	5	16.7
Junior high school	3	10
Senior high school	17	56.7
College	4	13.3

In terms of the body mass index, Table 2 below shows the information about BMI. Before giving the intervention, the mean body mass index of respondents was 26.49, and the after-mean body mass index was 25.67. The standard deviation before and after giving the intervention was 0.85 and 0.83, respectively.

Table 2. The Body Mass Index before and after giving the intervention.

Variable	n	Mean	Std deviation
Pre	30	26.4863	0.84791
Post	30	25.6740	0.82903

The bivariate results analysis of this study is in Table 3. It shows that the difference between before and after intervention is significant with *p-value* of 0.000. So, in other words, the intervention is significantly effective in decreasing the body mass index.

Table 3. The result of *Paired t-test* Analysis.

Observation	n	t	df	p-value
Pre	30	12.907	29	0.000
Post	30			

Bay leaves contain Vitamin B3, Vitamin C, and flavonoids. Flavonoids have been shown to inhibit body fat accumulation by reducing the activity of fatty acid synthase (FAS) in obese mice fed a high-fat diet (Cheon et al., 2021). Additionally, flavonoids have anti-obesity properties by reducing the absorption of carbohydrates and fats, which is essential in combating obesity (Liu et al., 2019). Existing studies have also demonstrated that flavonoids can regulate lipolysis, promoting weight loss and improving metabolic conditions associated with obesity (X. Yang et al., 2022). Flavonoids have been linked to preventing weight regain after successful weight loss (Lundgren & Thaiss, 2020). It has shown efficacy in treating conditions like intestinal mucositis and reversing weight loss (Miranda et al., 2020). Flavonoids have been associated with decreased body weight, as higher flavonoid intake has been linked to reduced body weight (Marranzano et al., 2018). Flavonoids have been found to have differential effects on adipogenesis, further supporting their role in weight management (Khalilpourfarshbafi et al., 2018). Specific flavonoids like quercetin and 8-Prenylnaringenin have shown promise in weight management. Quercetin has been reported to improve muscle mass and mitochondrial content, particularly in conditions like cancer and chemotherapy-induced cachexia (VanderVeen et al., 2022). On the other hand, 8-Prenylnaringenin, a hop flavonoid, has been identified as a food substance with health benefits (Tanaka et al., 2022).

Vitamin B3 may have potential benefits for overall health, including its impact on cholesterol levels and cellular metabolism (Sallabi et al., 2021). Vitamin B3 has been reported to lower total cholesterol, bad cholesterol (such as LDL), triglycerides, and lipoprotein levels in the blood, which are factors often associated with obesity. Moreover, vitamin B3 has been linked to potential protective effects against conditions that can lead to weight gain, such as inflammation-related degeneration in retinal ganglion cells (Chen et al., 2022). Vitamin B3 may inhibit apoptosis and promote autophagy of islet β cells under high glucose stress, which could have implications for metabolic health(Yu et al., 2023). Additionally, vitamin B3 is an important co-factor for cellular processes, including fatty acid metabolism and energy metabolism, which are crucial for overall health (Tinnevelt et al., 2020).

Vitamin C has been associated with reducing systemic inflammation by inhibiting pathways related to inflammation, such as CRP and TNF alpha, which can help protect against free radicals and decrease lipid peroxidation, potentially aiding in weight management (Totan et al., 2019). Vitamin C has been found to scavenge free radicals and suppress lipid peroxidation, which can lead to decreased vitamin C levels in obese individuals due to increased body fat and oxidative stress (Y. Yang et al., 2023). Vitamin C may inhibit metabolic changes induced by certain stressors like high-fat diets, with studies showing that high doses of vitamin C can induce weight loss safely in obese individuals (Yuan et al., 2021). Vitamin C has also been linked to inhibiting visceral adipocyte hypertrophy and lowering blood glucose levels in

high-fat-diet-induced obese mice, suggesting a potential role in combating obesity-related metabolic issues(Park et al., 2018). Vitamin C intake has been associated with promoting weight loss and reducing serum leptin levels, improving lipid profiles, and decreasing inflammatory biomarkers in obese individuals (Manuha, 2019).

There are other benefits of bay leaves. Syzygium polyanthum, commonly known as bay leaves, has been extensively researched for its potential health benefits. Studies have demonstrated its antioxidant, antidiabetic, and anti-inflammatory properties, with active compounds like flavonoids playing a key role in its therapeutic potential (Hadiyanti et al., 2023; Ismail & Ahmad, 2019). Research suggests that Syzygium polyanthum may help manage conditions such as hypercholesterolemia and diabetes mellitus (Muhammad et al., 2022). The plant is rich in antioxidants and antidiabetic agents, offering various health advantages (Halim & Maryani, 2022).Moreover, Syzygium polyanthum has shown promise in lowering blood glucose levels, possibly through its active compounds (Panambunan et al., 2019). Studies have also investigated its effects on histological changes in the kidney, indicating broader impacts on physiological functions (Muhammad et al., 2022).

The plant has been studied for its vasorelaxant effects, suggesting a potential role in managing blood pressure (Hassan et al., 2022). Syzygium polyanthum has been associated with anti-inflammatory properties, which could be beneficial for conditions like rheumatoid arthritis (Sulayha & Kustiawan, 2022). The traditional uses of Syzygium polyanthum in Indonesian and Malaysian cultures have been supported by scientific research, confirming its medicinal properties. From reducing cholesterol levels to improving insulin sensitivity and providing antioxidant effects, Syzygium polyanthum emerges as a versatile natural remedy with a range of potential health benefits.

However, there is a lack of existing studies evaluating the effectiveness of bay leaves in reducing body weight. To evaluate the potential impact of Syzygium polyanthum on body weight reduction, it is crucial to consider its documented health benefits. While the references provided focus on various aspects of Syzygium polyanthum, such as its antihypertensive, antidiabetic, and antioxidant properties, there is limited direct evidence on its specific effect on body weight reduction. The plant's active compounds, including gallic acid and other phenolics, have been associated with positive effects on metabolic health, which could indirectly influence body weight (Ismail et al., 2020; Ismail & Ahmad, 2019).

Research has indicated the potential of Syzygium polyanthum in managing conditions like diabetes and hypertension, which are often associated with weight management (Kustanti & Widyarani, 2023; Muhammad et al., 2022). The plant's capacity to lower blood glucose levels and enhance insulin sensitivity may contribute to overall metabolic regulation, potentially impacting body weight (Widodo, 2023). It is antioxidant properties and effects on inflammatory pathways could support overall health and potentially influence weight management (Rahim et al., 2021; Widyawati et al., 2021).

Bay leaves contain of Vitamin B3, Vitamin C, steroid, and flavonoid. Further research is necessary to gain a better understanding of the mechanisms of action and potential risks associated with herbal treatments for body weight reduction. This study found the fact that giving bay leaves for 14 days could reduce body weight. Future studies could add more details laboratory research to test the effectiveness of bay leaves in reducing body weight, especially among pre-menopausal obese adults.

4.   CONCLUSION

Bay leaves effectively reduce body weight after 14 days of intervention. Bay leaves contain Vitamin B3, Vitamin C, and flavonoids. The content of bay leaves can accelerate weight loss in premenopausal because it has a thermogenic effect. Bay leaves can be one herbal

prevention alternative to prevent the risk of obesity. This study is limited to certain time and place and can not be generalized to other time and place. Future studies can include more respondents and longer intervention time.

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Effectiveness of Javanese Turmeric (*Curcuma Xanthorrhiza Roxb*) to Improve Eating Behavior Among Anorexia Children in Bogor

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Abstract
Anorexia or lack of desire to eat and loss of appetite is a common issue among children. Some herbs were successfully tested to increase eating behavior, including Javanese turmeric or *temulawak*. This study aimed to examine the effectiveness of Javanese turmeric on eating behavior scores among children with anorexia. The study was done in Bogor Regency in January 2024. There were 30 children aged 4 to 6 years included in this study who were selected by the non-probability sampling method. Among them, 15 children were categorized into intervention or case group, and the rest as control group. The intervention is giving Javanese turmeric pudding. Before and after giving the intervention, the parents were asked to answer the children's eating behavior questionnaire (CEBQ). The finding by using *paired and independent t-tests* in this study revealed that Javanese turmeric is significantly effective in improving eating behavior (*p-value <0.05)* comparing pre and post-tests. This study can encourage the policymakers to do more education and promote of effectiveness of Javanese turmeric for health at the village and school levels. Future studies can improve the food variety made from Javanese turmeric to be more interesting for children.

Keywords: Javanese Turmeric, Temulawak, Appetite, Anorexia, Children.

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1. INTRODUCTION

Eating behavior is a critical factor in the risk of stunting in children. Anorexia which is also one eating behavior issue is defined as lack of desire to eat or loss of appetite, which is a common cause of parental concern in pre-school and school-going children. Various aspects of eating behavior have been identified as contributing to stunting. Poor feeding practices, such as irregular eating patterns, inadequate nutrition, insufficient food intake during illness, and poor nutritional content, have been recognized as significant risk factors for stunting (Wijhati et al., 2020). Additionally, studies have shown that slower eating compared to peers, being accompanied by grandparents or non-lineal relatives, and being induced to eat are associated with an increased risk of stunting (Ma et al., 2022). Furthermore, research has explored the influence of eating concepts on eating behavior and stunting, highlighting cultural factors related to food, food taboos, and early feeding (Diana et al., 2022). Maternal feeding practices have also been linked to the incidence of stunting, emphasizing the importance of understanding the relationship between maternal behaviors and child nutrition (Novitasari & Wanda, 2020).

Various studies have been conducted to investigate the relationship between stunting and eating behavior in children. The study on identifying causal risk factors for stunting in children under five years of age in South Jakarta, Indonesia, shed light on factors related to eating behavior (Utami et al., 2019). Another study analyzed nutritional factors affecting toddler stunting in Malang Regency, Indonesia, exploring how dietary practices and eating habits impact stunting in young children (Supariasa et al., 2023). Related to eating behavior or anorexia, some herbs can be appetizers to boost eating behavior. One endemic herb in Indonesia is *temulawak* or Javanese Turmeric *(Curcuma Xanthorrhiza Roxb).*

The *Curcuma Xanthorrhiza Roxb*., commonly known as *Temulawak*, has been extensively used in Indonesia for its medicinal and nutritional properties for a long time (Rahmat et al., 2021). Temulawak is a beneficial herbal plant that is widely recognized in Indonesia (Minarni et al., 2023). It is a native Indonesian medicinal plant with high value and is traditionally used as an ingredient in jamu, which is an Indonesian herbal supplement and medicine (Suniarti et al., 2019). Studies have shown that Temulawak extract has potential as a sunscreen gel (Wilapangga et al., 2023). Additionally, Temulawak is known for its antioxidant, anti-inflammatory, and anti-aging properties (Panjaitan et al., 2022). The content of curcumin and curcuminoids in Temulawak is believed to inhibit the growth of disease-causing bacteria (Alfarisi et al., 2022). Temulawak has been found to have antibacterial activity, inhibiting the growth of *Staphylococcus epidermidis* (Warmasari et al., 2020). Furthermore, Temulawak has been processed into instant drinks and other products to enhance its consumption (Septiana, 2020). Consuming Temulawak-based products can help boost the immune system (Idham, 2021). Temulawak has been compared to Korean ginseng due to its potential benefits, leading to it being referred to as "Indonesian ginseng" (Hariadi et al., 2022).

Regarding the evidence that Javanese turmeric has an impact on appetite, this study aimed to examine the impact of Javanese Turmeric on Improving children's eating behavior in the specific setting area in Bogor Regency because of the high percentage of children who were stunting based on the previous study in Bogor Regency (Wulandary & Sudiarti, 2021).

2. RESEARCH METHOD

This study is quantitative with a quasi-experimental approach. This current research was designed as a pre and post-test control group. This study was done in Taman Raya Citayam Housing Complex, Rawa Panjang Village, Bojonggede sub-district, Bogor Regency, West Java Province, Indonesia. The data collection was done from 01 January to 30 January 2024. The population of this study was children with poor appetite and eating behavior.

There are case and control groups with some intervention given. The data collection started by requesting the children's caregiver to fill out the questionnaire. Both groups were asked some questions related to children's appetite and eating behavior. Then the intervention group was given the Javanese turmeric jelly and the control group was not. The jelly was given for 3 times a week for one month. After giving the jelly, both groups were given the questionnaire again to measure the eating behavior of the children.

The sample in this study was selected by non-probability purposive sampling with a total of 30 children aged 4 to 6 years old. Criteria inclusion consists of approval of the parent to be given intervention, parents agreeing to answer both questionnaire pre and post-test, children aged 4 to 6 years old, poor appetite, mother as primary caregiver, children had no disability and healthy during the data collection. The exclusion criteria included children who did not consume any drugs, vitamins, or specific congenital disorders. Among them, 15 children were categorized randomly into the intervention group and 15 children as a control group.

The dependent variable of this study was children's appetite and eating behavior. It followed the guidelines from the Child Eating Behavior Questionnaire (CEBQ). CEBQ consists of 35 items including responsiveness to food, enjoyment of food, satiety responsiveness, slow eating, fussiness, emotional overeating, emotional undereating, and desire for drinks (Guthrie et al., 2001). The independent variable included Javanese turmeric pudding. This questionnaire was tested for its validity using Pearson correlation and Cronbach's Alpha ($r = 0.34$) and reliability (score: 0.98), indicating that the instrument was valid and reliable. The data was tested for univariate (min, max, mean, and standard deviation), and bivariate using *paired t-test and independent t-test.*

This study including instruments and tools has been approved by the Ethical Committee University of Muhammadiyah Purwokerto with reference number: KEPK/UMP/12/I/2024. Moreover, before the pudding was made, Javanese turmeric was tested for extraction and antioxidants from the Center of Laboratorium of Studi Biofarmaka, Institute of Agriculture Bogor with number 405.028/LPSB-IPB/I/24.

3.   RESULTS AND DISCUSSION

The solid Javanese turmeric was tested in the laboratory to check the ingredient content. By using HPLC (*High-Performance Liquid Chromatography)* analysis technique, for parameter *bisdesmetoksi curcumin* was .08 mg/g, *demetoksi curcumin* 0.60 mg/g, and *curcumin* 1.91 mg/g. All of those tests were done with solid Javanese turmeric. Table 1 below describes the general characteristics of the respondents. It shows that the highest percentage of the control and intervention group were children aged 6 years old, (40.00% and 46.67% respectively). In terms of sex, most of them were female for both the control and intervention groups (53.33% and 60.00%).

Table 1. The general characteristics of the respondents

Characteristics	Control group (n = 15)	Intervention group (n = 15)
Age (years old)		
4	4 (26.67%)	5 (33.33%)
5	5 (33.33%)	3 (20.00%)
6	6 (40.00%)	7 (46.67%)
Sex		
Male	7 (46.67%)	6 (40.00%)
Female	8 (53.33%)	9 (60.00%)
Knowledge (pre-test)		
Mean $\pm$SD	91.53 $\pm$ 4.94	90.73 $\pm$ 3.24

Knowledge (post-test)		
Mean $\pm$SD	93.40 $\pm$ 4.76	145.93 $\pm$ 4.32
Total	15 (100%)	15 (100%)

Table 2 below describes the score of eating behavior for the case or intervention group, the mean score for the pre-test was 90.73, and for the post-test was 145.93. Moreover, for the control group, the pre-test mean score was 91.53 and the post-test mean score was 93.40. Comparing the intervention and control groups, it was increasing scores from the pre-test and post-test. Moreover, it described the paired t-test result which revealed significant effectiveness between pre-test and post-test scores. Regarding that result, giving Javanese turmeric significantly improved the children's eating behavior.

Table 2. The Paired-t-test result of the impact of Javanese Turmeric on the Eating behavior of the children.

Group	Pre-test (Mean$\pm$SD)	Post-test (Mean$\pm$SD)	*p-value*
Intervention	90.73 $\pm$ 3.240	145.93 $\pm$ 4.317	0.000
Control	91.53 $\pm$ 4.94	93.40 $\pm$ 4.76	0.000

Table 3 below describes the independent t-test which revealed the significant differences in scores of eating behavior between pre and post-tests among the intervention group. However, it revealed insignificant differences in scores of eating behavior between pre and post-test among the control group. This finding supports the significant effectiveness of Javanese turmeric as an appetizer among children with anorexia or having a lack of appetite.

Table 3. The Independent t-test result of the impact of Javanese Turmeric on the Eating behavior of the children

Group	Intervention	Control	*Mean difference*	*p-value*
Pre-test	90.73 $\pm$ 3.240	91.53 $\pm$ 4.94	0.80	0.135
Post-test	145.93 $\pm$ 4.317	93.40 $\pm$ 4.76	52.53	0.000

The results in this study revealed the role of Javanese Turmeric in the process of responsiveness to food, enjoyment of food, satiety responsiveness, slowness in eating, fussiness, emotional overeating, emotional undereating, and desire for drinks. Javanese Turmeric is traditionally used to treat several ailments such as lack of appetite, stomach disorder, liver illness, constipation, bloody diarrhea, dysentery, arthritis, children's fevers, *hypotriglyceridaemia*, hemorrhoids, vaginal discharge, rheumatism, and skin eruptions (Rahmat et al., 2021). To date, over 40 active compounds, including terpenoids, curcuminoids, and other phenolic compounds, have been isolated and identified from *C. xanthorrhiza Roxb* (Khan et al., 2024).

Javanese turmeric with curcuminoids, is traditionally used in addressing issues like lack of appetite (Rahmat et al., 2021). Furthermore, research has demonstrated that turmeric can boost appetite, support the function of digestive organs, and enhance nutrient absorption in the body (Tugiyanti et al., 2022). Investigations on fish have revealed that curcumin found in turmeric can stimulate fish appetite and improve the absorption of nutrients (Cahyani et al., 2021). Additionally, studies have shown that curcumin in turmeric enhances palatability, thereby stimulating fish appetite and leading to increased growth (Purbomartono et al., 2023). Moreover, incorporating turmeric extract into feed has been proven effective in attracting fish and promoting their growth (Basuki et al., 2020).

Existing studies have shown that sensory processing issues, such as food fussiness, can limit the range of foods consumed and impact the social enjoyment of eating (Smith et al., 2020). Additionally, food preferences, particularly a preference for fruits or vegetables, have

been associated with increased enjoyment of food and decreased satiety responsiveness, slowness in eating, and food fussiness in children (Guzek et al., 2021).

Moreover, food fussiness has been linked to non-responsive parent feeding practices, like persuasive and instrumental feeding, which can further exacerbate picky eating behaviors (Markides et al., 2022). Maternal concern has been identified as a mediator in the relationship between child food fussiness and persuasive feeding, highlighting the role of parental attitudes in shaping children's eating behaviors (Harris et al., 2018). Furthermore, fussy eating has been associated with lower levels of food involvement among children, indicating that engaging children in meal preparation and grocery shopping may help reduce food fussiness (Broad et al., 2021).

In terms of emotional eating behaviors, studies have found that body mass index is positively correlated with emotional overeating, enjoyment of food, and food responsiveness while being negatively correlated with satiety responsiveness, emotional undereating, slowness in eating, and hunger (Dubois et al., 2022). This suggests that emotional eating tendencies can impact weight status and eating patterns.

The studies specifically focus on Javanese turmeric found to solve the anorexia issue. A systematic review and meta-analysis of herbal medicine for the treatment of anorexia in children indicates the potential of herbal remedies in managing anorexia symptoms (Lee et al., 2022). A study in Indonesia explored the sensory characteristics, chemical composition, and antioxidant activity of egg rolls with the addition of Javanese turmeric, highlighting the potential use of this herb in enhancing the sensory properties of food products (Rahman, 2023). These studies suggest that herbal medicines, including Javanese turmeric, may offer potential benefits in managing anorexia in children. These studies are relevant to the use of Temulawak *(Curcuma xanthorrhiza)* for increasing children's appetite. In the Indonesian context, a study on the training for making anti-stunting food for children in a fishing village, emphasized the importance of providing creative and varied foods, setting meal schedules, and giving appetite enhancers/vitamins (Rizkaprilisa et al., 2022). One study explored the implementation of complementary therapy for preventing stunting in health-integrated posts in the village, highlighting various efforts, including complementary therapy, to increase children's appetite (Hadi & Primasari, 2023). Furthermore, a study investigated the effect of giving papaya fruit to increase appetite in toddlers in the Tilango Health Center area, focusing on the impact of papaya consumption on enhancing children's appetite (Mulyaningsih et al., 2022).

According to findings in this study and several studies discussed above, Javanese turmeric effectively increases the eating behavior score among children with anorexia or lack of appetite.

4. CONCLUSION

Regarding to results of this study, Javanese turmeric effectively increases the eating behavior score among children with issues of appetite. Future studies can improve the taste, shape, and color of food made from Javanese turmeric to be more interesting for children. At the national level, there is a need for health promotion and education about the Javanese turmeric ingredients content, the cooking process to prevent loss of ingredients, and its usefulness for health, especially as an appetizer. It can start from the small unit of health integrated post in the village (*Pos Kesehatan Terpadu/Posyandu*) with training the cadres. At the school canteen, this food can be provided to prevent the children from consuming junk and fast food.

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R E S E A R C H   **Open Access**

Development of Learning Methods Basic Life Support Based on E-Learning Program for Nurses: Literature Review

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Abstract
Basic Life Support (BLS) training is a must for nurses before entering the world of work. During the establishment of the pandemic in Indonesia, many face-to-face interactions were limited. The limitation also impacts the learning method of nurses. Most of the institutions use the E-learning (online) method. E-learning in nursing study has several advantages, such as being efficient, economical, and flexible. However, it also has disadvantages such as internet access, lack of interaction, and lack of direct practice with the media. This literature review aims to find the best e-learning methods for BLS training. The research design is a literature review. The article was conducted in three journal databases: Google Scholar, Scopus, and PubMed. A total of 16 articles that met the inclusion criteria were reviewed. The study showed that blended learning is the best recommended learning method for BLS. Combined learning methods improve the knowledge and skill performance of the students.

Keywords: E-learning, Learning Methods, Nursing, Basic Life Support.

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1. INTRODUCTION

The rapid development of information and communication technology in the digitalization era encourages various educational institutions to utilize e-learning systems. E-learning-based training is one of the system implementation forms. The purpose of e-learning-based training is to increase the effectiveness and flexibility of learning. Although many research results showed that the effectiveness of learning using an e-learning system tends to be the same as conventional or classical learning, the advantage of e-learning is its flexibility (Yahiaoui et al., 2022). Through e-learning, the materials can be accessed anytime and anywhere. The materials also can be enriched with various learning resources, including multimedia, that the teacher can quickly update. Due to the relatively new development of e-learning, the definition and implementation of e-learning systems vary significantly, and a standardized standard needs to be established (Sheikhaboumasoudi et al., 2018). Based on observations, the implementation of e-learning systems varies from the simple one, just a collection of learning materials placed on a web server with additional online communication forums, to the integrated one, an e-learning portal containing multiple learning objects and academic information. As for the actual teaching and learning process, especially in countries where the Internet connection is prolonged, e-learning systems can be combined with a conventional learning system known as blended learning or hybrid learning systems (Picciano, et al., 2022).

Flexibility is the keyword in an e-learning system. Learners become very flexible in choosing the time and place of learning because they do not have to come somewhere at a particular time. On the other hand, teachers can update their learning materials anytime and anywhere. Learning materials can be made very flexible in content, ranging from text-based materials to learning materials loaded with multimedia components. However, the quality of learning with e-learning is also very flexible or varied, which can be worse or better than face-to-face learning systems (conventional). To get an excellent e-learning system, we need to build an excellent design too (Suartama, 2014; Nurhasanah, et al., 2019).

E-learning can be used in various training and learning, especially in applying basic life support training (Adnyani, et al., 2023). BLS training, which takes references from the American Heart Association (American Heart Association, 2020), is widely used as a material reference for training health workers and non-experts. BLS training can increase the community's understanding, increase knowledge, and increase the ability to practice, and the community can spread the information to friends and others (Agustini, et al., 2017; Nurjanah, & Suparti, 2022; Rahman, et al., 2022). The implementation of training during the pandemic has experienced difficulties. All face-to-face activities are limited, including training or learning. The limited face-to-face activity has caused many e-learning-based learning models designed to support ideal learning, like face-to-face learning, to emerge (Singh, et al., 2021).

Although the e-learning design has been designed in such a way, it still has some obstacles for the users. A study by Taher, et al., (2022) states that 64.8% of students are not satisfied with implementing e-learning. Only 35.5% of students take electronic classes. The obstacles felt by students are slow internet speeds, electrical interference, and lack of face-to-face interaction. The results of this study are also supported by the data on the achievement of e-learning implementation in the Bunda Group Corporation, where the Workspace Completion Rate (Corp et al. Method) reached 74% in 2022 so that SP (Warning Letter) was imposed in the form of punishment from the corp which was used to increase the completion rate to 98.6%, but this could not increase nurses' interest in learning (Dempsey et al., 2021).

Other data that can be used as the basis for taking this theme is the success rate of implementing cardiopulmonary resuscitation in hospital service units in 2022. The success rate did not reach 80% even though mandatory BLS training has been carried out using the e-

learning method. The result showed that the e-learning method is ineffective in ensuring success in practical skills (Joshi et al., 2022).

So, from this gap and existing problems, researchers are interested in conducting a literature review article to find a suitable e-learning-based BLS learning model for nurses to enhance their interest in learning and improve their skills and knowledge.

2. RESEARCH METHOD

This research was conducted using the literature review method. A literature review is a scientific approach that aims to analyze, evaluate, synthesize, and criticize a research finding on a particular topic or topic that has been published online and in print. The selected articles are from research on applying the e-learning-based nurse basic life support learning model to increase interest in learning. The strategy used to search for articles uses the PICOS framework, as explained in Table 1.

Table 1. PICOS Literature Review.

Criteria	Inclusion	Exclusion
Population	Nurse, Nursing, Medical Student	Not nurse, not medical students
Intervention	E-learning methods, blended learning	Not seminars or symposia, or workshops
Comparators	Not described	Not described
Outcomes	Best E-learning methods for Basic Life Support	Not explain about training methods or e-learning methods for BLS
Study Design and publication type	Quasi-experimental studies, Qualitative survey or research, Cross-sectional Survey randomized control and trial, Mix Methods	Literature Review or Scoping review article
Publication years	2018	2023
Language	English, Indonesian	Language other than English and Indonesian

The inclusion criteria used:
1. An article that discusses e-learning based on basic life support training for nurses, which is used to increase students' interest in learning basic life support
2. Articles from the research model: Quasi-experimental studies, Qualitative survey or research, Cross-sectional Survey, randomized control and trial, mixed methods.
3. Articles published in Indonesian and English from 2018 to 2023.
4. Articles published in journals that go through a peer-review process.
5. Articles with full text.

Article searches were conducted using boolean operators (AND, OR NOT, or AND NOT) to expand or specify the search, making determining the articles or journals used easier. The keywords in this literature review are adjusted to the Medical Subject Heading (MeSH) and consist of the following:

Table 2. Keyword of Literature Review

Basic Life Support	Learning Methods	Nursing	E-learning
OR	OR	OR	OR
BLS	Learn Methods	Nurse	Electronic learning
OR			
Training Basic life support			
OR			
Training BLS			
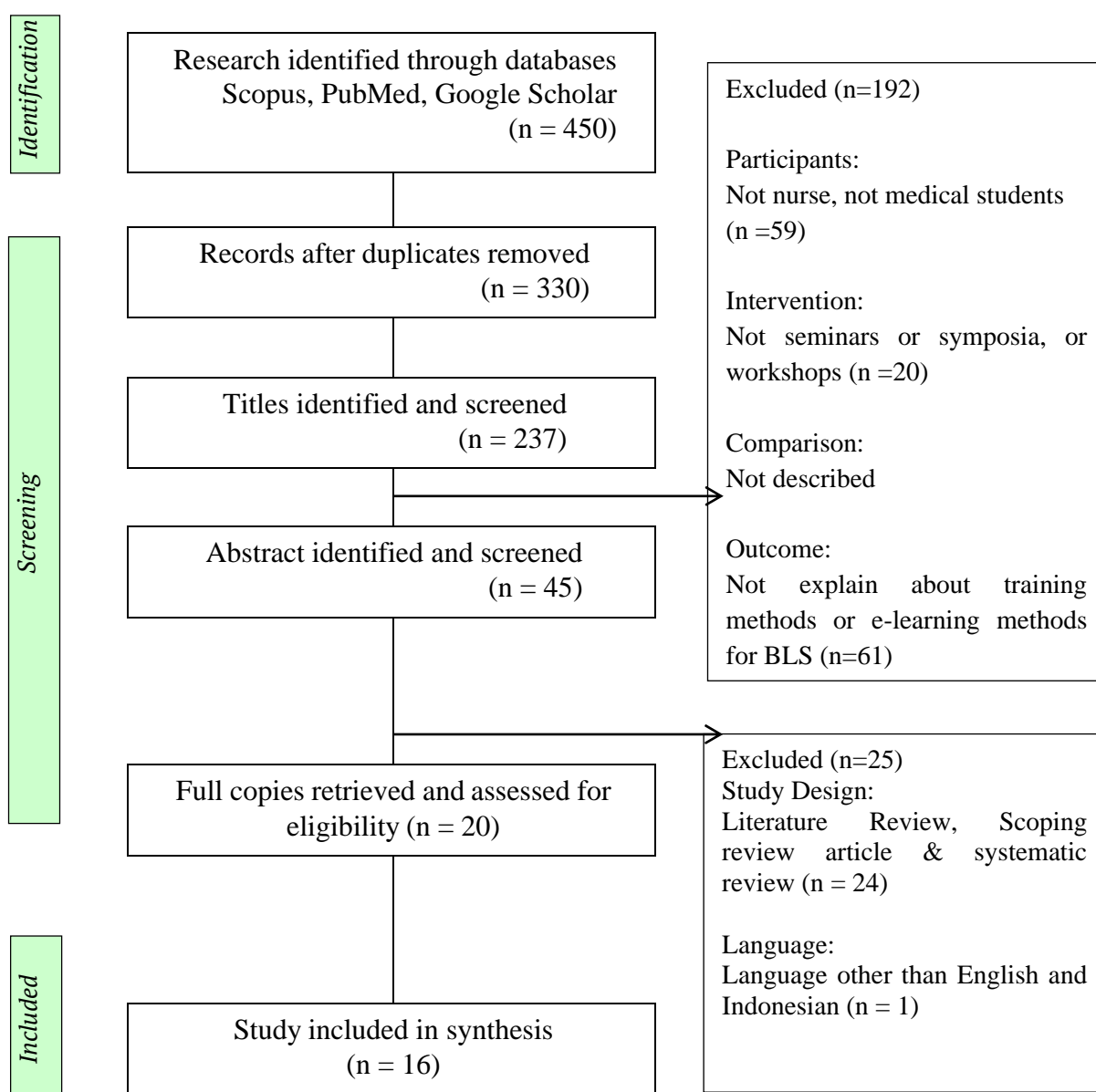
Figure 1. PRISMA Diagrams

Based on the results, a total of 450 articles matched the keywords. The search results obtained are then checked for duplication, finding that 120 articles are the same, so they are excluded, and 330 remain. The researcher then screened based on the title (n = 237); in the title, the researcher conducted a deep PICOT analysis to screen 192 articles based on the exclusion criteria. In the abstract (n = 45), screening was carried out based on study design and language and excluded 25 articles. The full text (n = 20) was adjusted to the literature review theme in the final screening stage, and 16 articles were obtained. An assessment based on the inclusion and exclusion criteria eligibility obtained 16 articles that could be used in the literature review.

The study used the CASP (Critical Appraisal Skills Programme) form for quality appraisal (CASP, 2024). The study selection in this research starts with identifying the journal articles based on inclusion and exclusion criteria, screening the journal articles, and including them. After 16 articles were selected, the researcher extracted the data from each journal, consisting of title, author, years, study, sample, variable, instrument, and analysis summary, as shown in Table 3.

3. RESULTS AND DISCUSSION

Table 3. Literature Search Result

No	Title	Authors and years	Study design, Sample, Variable, Instrument, Analysis	Summary of Results
1	Development of an Extended Reality Simulator for Basic Life Support Training	Lee et al, 2022	Design: Quantitative Sample: Sixteen experts participated Variable: BLS simulator without instructors Instrument: Learning mode & practice mode Analysis: Usability test	The Extended Reality (XR)-BLS simulator is useful and can conduct education without requiring instructors and trainees to gather

2	Dissemination of Cardiopulmonary Resuscitation Training for Nurses Treating Coronavirus Disease-2019 Patients: A Single-arm Pre-experimental Study	Joshi et al, 2022	Design: Pre-experimental study Sample: 160 nurses Variable: online study material, skill nurse Instrument: questionnaire Analysis: a paired "t" test	A well-structured, online study material can impart knowledge and demonstrate the basic and essential skills nurses require for CPR for COVID-19 patients.
3	The Impact of e-Learning Systems on Motivating Students and Enhancing Their Outcomes During COVID-19: A Mixed-Method Approach	Yahiaoui et al, 2022	Design: Mix Methods (quantitative and qualitative approaches) Sample: 400 student (snowball sample) Variable: *E-learning* systems, student motivation, student entrepreneurship Instrument: Questionnaire Analysis: -Quantitative using structural equation modeling (SEM) through IBM SPSS -Qualitative using visualization techniques analysis, cluster analysis, and cognitive mapping.	The quantitative showed : • Positive significant correlation between e-learning systems and student motivation • Positive significant relationship between student motivation and student outcomes • Students' positive attitudes towards the e-learning system outnumber negative attitudes, positively influencing student motivation and learning outcomes.
4	E-Learning Satisfaction and Barriers in Unprepared and Resource-Limited Systems During the	Taher et al, 2022	Design: Descriptive statistics Sample: 870 Students Variable: socio-demographic, *E-learning* program, students' perspectives, barriers experienced Instrument: Questionnaire	The study result showed: • Approximately 64.8% of students are dissatisfied with the experience of using E-learning • Only around 35.5% of students are taking synchronous electronic

	COVID-19 Pandemic: Descriptive statistics		Analysis: Data were analyzed using the SPSS software program version 26 released in 2019 by IBM Corp, Armonk, NY	classes while the remaining students use asynchronous learning activities • Students' level of satisfaction was poor, as only 6.4% of students strongly believed that tutoring was informative and that educational technology was adequate. • In contrast, 69% of students strongly agreed that *E-learning* saved them time and money • The student perceived the barriers were slow internet speed, power interruption, and the lack of face-to-face interaction
5	Piloting a Basic Life Support instructor course: A short report	Nabecker et al, 2022	Design: Quantitative Sample: 31 healthcare providers in 4 courses Variable: pilot shortened Basic Instructor Course Instrument: questionnaire Analysis: Chi-square	The result showed: • Participants of the pilot shortened Basic Instructor Course in a healthcare setting were successfully trained to teach the European Resuscitation Council's Basic Life Support provider courses in a short four-hour format. • The pilot course seems highly likely to allow future instructors to teach courses in the provision of Basic Life Support training.

				• Very high motivation to teach can result in four times as many instructors being able to teach the course after the pilot course compared to the standard course.
6	Medical students' perception towards E-learning during COVID 19 pandemic in a high burden developing country	Gismalla et al, 2021	Design: Descriptive cross-sectional survey Sample: 358 undergraduate medical students Variable: medical student opinion regards starting the *E-learning* Instrument: self-administered online based questionnaire Analysis: Chi-square test	E-learning as a teaching tool of medical education can offer an effective alternative to the traditional on-site education format and help solve the shortage of healthcare providers and educators.
7	A survey of E-learning methods in nursing and medical education during COVID-19 pandemic in India	Singh et al, 2021	Design: Cross-sectional survey Sample: 1541 medical and 684 students Variable: online teaching methods -> as feasible, acceptable, and effective as in-class teaching Instrument: Online questionnaire Analysis: chi-square test	The result showed: • PowerPoint presentation was the most commonly used (80%) method [medical (92.6%), nursing students (50.3%), $p < 0.0001$]. • Other methods employed were didactic lectures without any aids (22%), case-based learning (52.7%: medical-61%, nursing 33.9%, $p < 0.0001$), video-based learning (50%), interactive sessions (41%), recorded lectures (46.8%), quizzes (38.1%), virtual models using on classes (24.5%) and online whiteboard teaching using diagrams (24%).

| 8 | Nursing students' and educators' experience with e-learning during a pandemic: An online survey | Eltaybani et al, 2021 | Design: Cross-sectional design
Sample: 675 participants (nursing students =580 and nursing educators = 95)
Variable: Nursing students' and educators' experiences with *E-learning* during the COVID-19 pandemic and preferences for responding to online versus paper questionnaires
Instrument: questionnaires (google form)
Analysis: T test or the χ2 test | The current study showed:
• Student's overall satisfaction and competency with e-learning were significantly lower than that of educators. Likewise, student evaluation of the overall quality of the e-learning system process is significantly lower than that of educators. This may reflect the participants' positive attitude in using e-learning as an alternative teaching approach during the COVID-19 pandemic.
The perception of some students in this study was much lower than that of educators about the possibility of taking online exams. |
| 9 | Students' perception of online learning during the COVID-19 pandemic: A survey study of Polish medical students | Bączek et al, 2021 | Design: Observational Study-descriptive statistics
Sample: 804 participants students
Variable: demographic details, advantages and disadvantages of *E-learning*, likers scale of face-to-face learning with online learning, rate the level of acceptance of online classes
Instrument: Questionnaire
Analysis: Chi-square, Mann–Whitney tests and the | This study showed:
• *E-learning* is a valuable method of teaching medical students.
• *E-learning* is effective in increasing knowledge and is highly accepted
There is no statistical difference between face-to-face and online learning, which is seen from the opinion of the method's ability to increase knowledge. |

No	Title	Author	Method	Result
			nonparametric Wilcoxon signed-rank test	
10	Lean Six Sigma Redesign of a Process for Healthcare Mandatory Education in Basic Life Support-A Pilot Study: Qualitative Study	Dempsey et al, 2021	Design: Qualitative Sample: 82 participants Variable: process accessing mandatory training (mandatory training program of Basic Life Support) Instrument: Intervention Design Analysis: : Chi-square	This study showed: • The redesign of the BLS training program resulted in a new blended delivery method • The redesign of the BLS training program increased 50% in Basic Life Support (BLS) class volume and The redesign of the BLS training program estimated savings time for about 154 hours 30 minutes for staff and 48 hours 14 minutes for instructors.
11	E-Learning perception and satisfaction among health sciences students amid the COVID-19 pandemic: Qualitative Survey Study	Abbasi et al, 2020	Design: Qualitative Survey-Questionnaire Sample: 1255 participants student Variable: experience and perception of *E-learning* among the student Instrument: Questionnaire by upload on Google survey Analysis: t-test and spearman	• The majority of participants agreed that E-learning is very satisfying in acquiring knowledge E-learning is not practical for acquiring clinical and technical skills.
12	Mastery versus self-directed blended learning in basic life support: a randomized controlled trial	Madou & Iserbyt, 2019	Design: Experimental groups Sample: 145 students Variable: Mastery learning (ML) versus a self-directed learning (SDL) -> The effect Instrument: A randomized controlled trial Analysis: Shapiro–Wilk's test	All blended learning models are very time-saving because the face-to-face component only takes about 45 minutes, and learning outcomes will follow the guidelines.

13	Animation and interactivity facilitate acquisition of pediatric life support skills	Lehmann et al, 2019	Design: prospective study Sample: 103 medical students Variable: self-instructional videos on Pediatric basic life support (PBLS), an animation-enriched VP group with VP containing interactive questions and animated media, and a static VP group with VP Instrument: Experimental and causal comparative studies Analysis: : Chi-square	• Virtual Patient (VP) can feasibly enhance PBLS skill acquisition. Thoughtful Virtual Patient (VP) animation and interactivity design can increase the acquisition of performance and compliance with temporal demands skills
14	Nursing students, knowledge, attitude, self-efficacy in blended learning of cardiopulmonary resuscitation	Moon and Hyun, 2019	Design: randomized control design Sample: 120 nursing Variable: blended learning CPR education program, knowledge, attitude, and self-efficacy Instrument: questionnaire Analysis: paired t-test	A blended learning Cardiac Pulmonary Resuscitation program (monocentric study) that integrates videos and face-to-face meetings was effective in increasing knowledge and attitudes among nursing students, particularly in Cardiac Pulmonary Resuscitation.
15	Basic life support and external defibrillation competences after instruction and at 6 months comparing face-to-face and blended training. Randomized trial	Castillo et al, 2018	Design: Experimental Sample: 129 student medicine of nursing Variable: training video, a new website, a Moodle platform, an intelligent manikin, and 45 min of instructor presence Instrument: a multi-choice questionnaire (MCQ) Analysis:	The blended method provides the same or even higher levels of knowledge and skills than standard instruction immediately after the course and six months later.
16	Self-learning basic life support: A randomized	Pedersen, 2018	Design: Experiment Sample: 152 students	• Self-learning is not inferior to facilitator-led learning in the short-

controlled trial on learning conditions	Variable: Basic Life Support self-learning without supervision or BLS teaching Instrument: randomized controlled trial Analysis: Mann-Whitney U test for non-paired data and Wilcoxon signed-rank test for paired data	term Independent learning resulted in better retention of Basic Life Support skills three months after the training compared to training led directly by the facilitator.

Based on 16 articles that have been reviewed, this study will discuss the effectiveness of e-learning, e-learning learning models, and Basic Life Support learning models.

The results showed many opinions on the effectiveness of E-learning implementation. Yahiaoui et al. (2022) explained the relationship between the e-learning system and learning motivation. This learning motivation can provide positive learning outcomes for nurses towards e-learning. Eltaybani et al. (2021) argue that students express satisfaction with e-learning on average. This is reflected in the attitude of participants who are open to using e-learning as an alternative teaching approach but not for imp rather than online examinations. Bączek et al. (2021) and Abbasi et al. (2020) explain that e-learning effectively improves learners' knowledge. A study by Baczek also compared face-to-face and online learning but found no significant difference. This finding is supported by the theory of Abbasi et al. (2020) that e-learning is not meant to improve learners' clinical skills. E-learning is usually used as an alternative to solving problems found during conventional learning, where this learning requires on-site learning, especially in healthcare facilities that will conduct learning or training and education service providers (Gismalla et al., 2021). Study by Taher et al., (2022) stated that participants are not satisfied with the experience of using e-learning. The causes are unstable internet speed and lack of face-to-face interaction between participants and presenters.Another study by Agustini, et al., (2020) about the effect of health education about emergency condition on the knowledge and ability of parents in handling children with emergency condition showed that on-site learning method (lecture method) is effective in increasing the knowledge and ability of the parents. Lecture method let the parent to have an interaction with the other parents in sharing about how to deal with emergency situation in children. In conclusion, on-site learning has a good effect on the delivery of information given by the speaker, but the existence of blended learning provides solutions in the time constraints and the variation of methods that can be used in the learning model, to provide a better learning outcome.

The learning model presented by Nabecker et al., (2022) explains that participants who used the Pilot Shortened Basic Instructor Course successfully attended the Resuscitation Council's Basic Life Support training in Europe. Implementing training with this program will take about 4 hours faster than the usual learning model. A study by Singh et al., (2021) also explained the results of their study that the best learning methods are (1) PowerPoint, (2) video-based learning, (3) interactive sessions, (4) recorded lectures, (5) quizzes, (6)virtual models, (7) whiteboard teaching. This theory is supported by the opinion of Madou & Iserbyt (2019), who states that the blended learning

model significantly saves training time compared to face-to-face learning.

BLS training is the primary training to save patients from respiratory and cardiac arrest (American Heart Association, 2020). The emergency care competencies of nurses in BLS can be improve through continous education and training (Sanjana, 2023). According to Moon and Hyun (2019), who discussed the implementation of blended training, this training model combines several existing training models. In this article, blended training combines video and face-to-face learning. This combined training improved the knowledge and attitudes of cardiopulmonary resuscitation (CPR) trainees (Puspa, et al., 2023; Alsoufi, et al., 2020). Another researcher who took the topic of blended methods is Castillo et al. (2018), who mentioned that blended methods can improve the knowledge and skills of learners both immediately after training and six months later (long term).

Research by Dempsey et al. (2021) states that blended methods design can increase the volume of BLS classes. The increase in BLS training classes aligns with the increase in participants' interest in learning. Demsey also claimed that this blended methods design can save training time. Meanwhile, Pedersen (2018) explains that self-learning BLS can increase the memory of the material learned compared to using facilitator-led learning. The learning model is expected to be well structured because structured online studies can provide knowledge and demonstrate basic and critical skills for nurses in performing cardiopulmonary resuscitation (CPR) (Joshi et al., 2022).

Several researchers have made innovations in developing supporting tools for conducting training, especially BLS training. A study by Lee (2022) stated that the Extended Reality (XR) as a BLS simulator is very helpful for BLS training without a trainer. XR is a simulator that combines the virtual and real world. This XR simulator must use virtual reality (VR). VR is a device that allows users to see what the world is like, like seeing the natural world. Also, it allows them to interact in cyberspace, such as conducting cardiopulmonary resuscitation (CPR) training with fictitious patients, in line with the study by Lehmann et al., (2019), who conducted research on virtual patient (VP) in pediatric essential life support (PBLS) training. VP is a form of e-learning development that designs an application that inputs several conditions and clinical criteria of the patient, just like the patient's condition experiencing the disease in real-time. So, in their research, Lehmann et al., (2019) argue that this VP can improve the skills of PBLS training.

From the reviewed articles, almost all participants said they were satisfied with implementing the E-learning learning model. E-learning has a positive correlation with:
1. Motivation
2. Knowledge
3. Learning Alternative
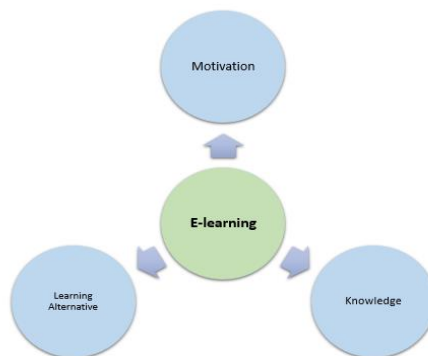
Figure 2. Correlation of E-learning

In addition to increasing motivation and knowledge, e-learning can be an alternative when students face difficulties in implementing face-to-face learning because of the distance between learners and material providers who are not in a place or time and limited direct learning space. The flexible principle in e-learning has been discussed in the E-learning Concepts and Applications book (2014), where e-learning refers to delivering learning materials to anyone, anywhere, and anytime by using various technologies in an open, flexible, and distributed learning environment. Furthermore, open and flexible learning refers to learners' freedom in terms of time, place, pace, content, learning style, type of evaluation, and collaborative or independent learning.

The number of learning models obtained from journal discussions in the search for excellent outcomes causes the need for grouping, which makes it easier for researchers to develop learning models. Picciano et al., (2022) explain that Blended Learning is a combination and match between face-to-face training and online training, which will be arranged according to the learning needs designed.

Figure 3. AHA Chains of Survival for Adult IHCA and OHCA

According to American Heart Association, (2020), Chains of Survival is an organized method so learners can easily understand what is involved in saving human life. It is necessary to distribute the material made with this structure based on the results of the articles reviewed using Blended Learning. Blended learning combines conventional learning (face-to-face) with learning that utilizes information and communication technology (Nasution & Jalinus, 2019s). Recommendations for grouping material based on the BLS American Heart Association, (2020) can use learning methods classified according to J.R David in the book "Learning Strategies (2019)" where the learning method here can be interpreted as a method used to implement plans that have been prepared in the form of fundamental and practical activities to achieve learning objectives. Several learning methods can be used to implement learning strategies, including: (1) lecture; (2) demonstration; (3) discussion; (4) simulation; (5) laboratory; (6) field experience; (7) brainstorming; (8) debate, (9) symposium. The composition of the blended learning model that wants to be applied to BLS learning is 50/50%, meaning that the time allocation provided 50% for face-to-face activities and 50% for online learning activities (Nasution & Jalinus, 2019). The consideration of using this 50/50% blended learning composition is to provide learning results that are more effective, efficient, and interesting and improve understanding of material and skill.
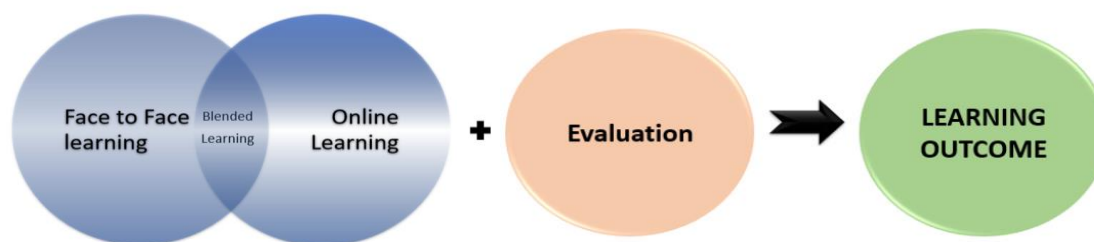
Figure 5. Blended Learning Model

4. CONCLUSION

From the discussion above, the learning model that can be recommended in learning Basic Life Support nurses based on e-learning is the Blended Learning model, where the learning model by combining face-to-face learning and online learning (e-learning) is proven effective in improving students' knowledge and skills.

ACKNOWLEDGMENT

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R E S E A R C H   **Open Access**

The Impact of Modular Professional Nursing Care Model (Modification of The Primary-Team Model) on Patient Satisfaction in Health Services: A Literature Review

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Abstract
Optimal health services are considerably increasing patient satisfaction. Optimization of health services could be implemented using the Modular Professional Nursing Care Method (MAKP Modular). MAKP Modular provides a clear division of tasks and responsibilities for nurses in accordance with the distribution of nursing staff. This literature review aimed to identify the effect of MAKP Modular in increasing patient satisfaction through the optimization of health services. The research design is a literature review. The journal article was conducted on the Google Scholar journal database website and 10 journal articles were selected according to inclusion criteria. The results of the review show that the application of MAKP Modular affects the quality of implementation of nursing care standards. The performance of nurses manifested in the implementation of MAKP Modular also influences patient satisfaction. However, there are still some deficiencies in the application of modular MAKP in the health service setting. These deficiencies are influenced by factors of knowledge, attitudes, and motivation of nurses. The application of MAKP Modular to the healthcare system is conducted by combining the team method and the primary method. The combination of these two methods allows for a more effective and efficient process of providing nursing care. Evaluation of the implementation of MAKP Modular in clinical and hospital settings needs to be engaged on an ongoing basis to determine the effectiveness of implementation.

Keywords: Modular Nursing Model, Patient's Satisfaction, Team-Primer Nursing Model, Nurse Performance.

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1. INTRODUCTION

The quality of health services is an aspect that is assessed from the perspective of health service performance, funders, owners of health service facilities, and patients who use health services (Pohan & Imbalo, 2007). Patient satisfaction is one of the things that is measured in assessing the quality of health services. Patient satisfaction is the key to the success of health services accomplishment (Suratri et al., 2018). Nursing care is part of the health services execution. Optimal nursing care could increase patient satisfaction. Improving nursing care services could be implemented by using the Professional Nursing Care Model (MAKP) system (Kanang et al., 2020).

The Professional Nursing Care Model (MAKP) is a framework that includes 4 elements, namely standards, inclusive processes, inclusive education, and the MAKP system (Andung et al., 2017). These four elements allow nurse management to provide professional nursing care (Dion et al., 2019). The existing Professional Nursing Care Model is divided into 4, namely Team-model, Primary-model, Case-model, and Modular (Team-Primary Modification) (Andung et al., 2017). The current MAKP implementation in health services certainly has several obstacles that seem to affect patient satisfaction and the quality of health services. One of the dominant obstacles found is the lack of communication between nurses in providing nursing care (Bidjuni, 2017; Lobo dkk., 2019). The strategy that can be used to overcome these problems is to implement MAKP Modular (Sofiatun et al., 2022).

The Modular Professional Nursing Care Model is a method of providing nursing care led by a leader nurse and primary nurse with a Nurse education level. The primary nurse will lead the regular nurse who is at the Diploma III level of Nursing and SPK (Cooperation Education Unit). The combination of the lead nurse, the primary nurse, and the regular nurse will provide professional nursing care to patients from the time the patient arrives until they return home (Nursalam, 2017). Nurses have more time to provide nursing care to patients directly. Nurses also carry out tasks in the same and continuous modules so that service quality could be improved (Yoder & Wise, 1999; Fitriana & Fadila, 2023; Patoding & Sari, 2022).

According to research conducted in 2022 on the development of the Modular Nursing Care Model (MAK), the variables of organizational characteristics, individual characteristics, job characteristics, and work productivity-based Modular MAKP have a significant impact on the variables pertaining to patient satisfaction (Sofiatun et al., 2022). According to Andarukmi (2008) correlation study of Modular MAKP and patient satisfaction, the use of Modular MAKP in nursing care has a positive correlation with patient satisfaction. The Modular Professional Nursing Care Model (MAKP) provides nurses with a clear division of duties and responsibilities based on the division of nursing staff (Hasibuan dkk., 2021).

Conditions that can be applied to the modular nursing care method are in hospital settings that wish to develop the primary form but cannot do it purely because the primary nurse must have a minimum educational background of a Bachelor of Nursing. Another condition is that financing services cannot use the team method purely because they do not want nursing care to be divided into various teams. Therefore, combining the two models is expected to maximize the objectives of the primary data method and the team, to improve the quality of services provided to patients (Sudarsono, 2000). Based on the explanation above, the researcher is interested in compiling a literature review to find out more about the application of Modular MAKP (Team-Primer Modification) in increasing patient satisfaction. The purpose of this literature review is to identify the impact of MAKP Modular in increasing patient satisfaction.

2.   RESEARCH METHOD

This study uses the literature review method. A literature review is a scientific approach that aims to synthesize, criticize, evaluate, and analyse research that has been published online or in print (Fink, 2014). Articles were selected based on the suitability of the topic and several keywords used in searching journals on the Google Scholar online journal database. Some of the keywords used are "Modular Nursing Model", "Patient Satisfaction", "Primary-Team Nursing Model", "Nurse Performance", "Health Service Quality", and "Modular MAKP". The inclusion criteria in the selection of articles are (1) Articles with the discussion of MAKP Modular (Modification of the Primary-Team Nursing Model); (2) Articles discussing patient satisfaction with health services; (3) Articles available in full text; (4) Published journals/articles in the last 10 years. After obtaining several journals/articles, those are selected according to the research theme. There were 144 journal articles and 10 articles that met the inclusion criteria for review.

Identification	Google Scholar (n=144)	
Screening	137	Articles duplication (n=7)
Eligibility	10	Article Excluded (n=127) Tittle review and abstract (n=97) Not full-text (n=8) Not related to the scope of study (n=22)
Included	10	Articles met criteria (n=10)
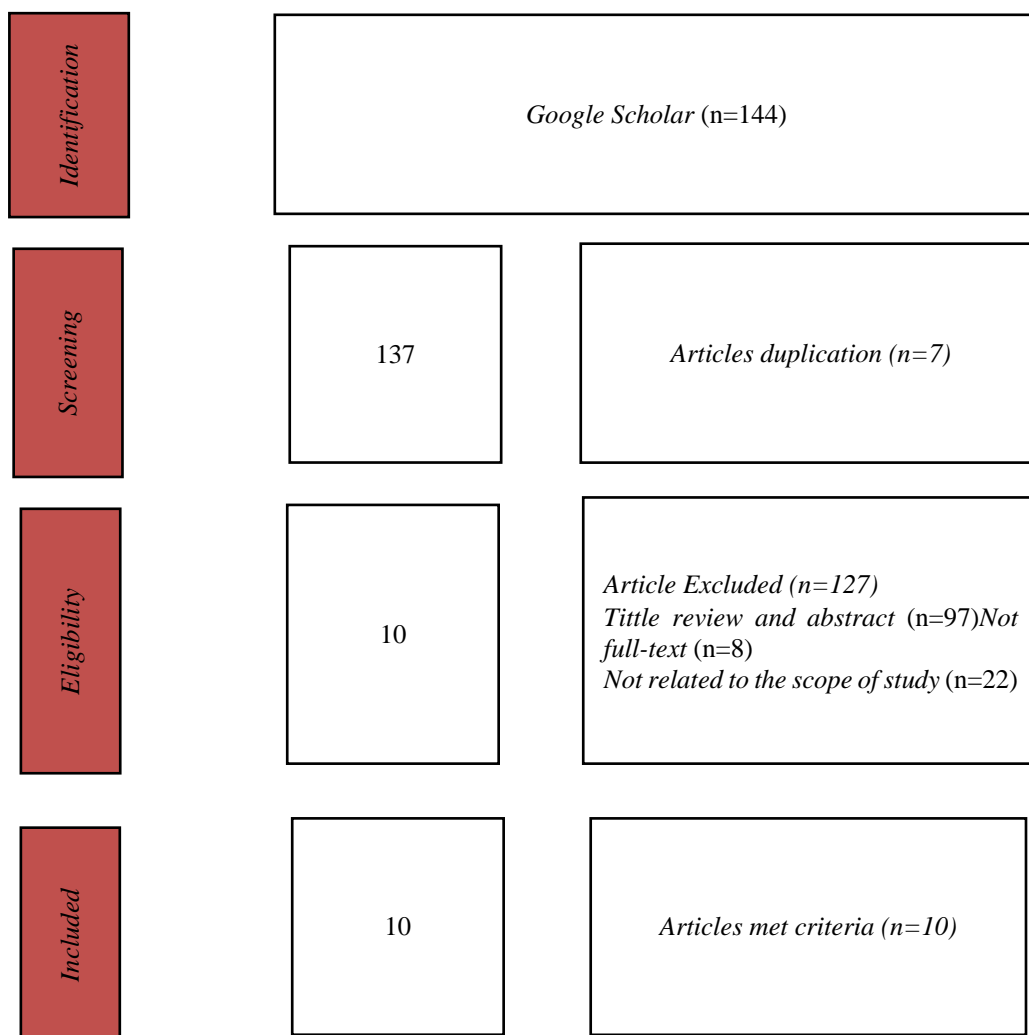
Figure 1. PRISMA Diagram

Based on the PRISMA Diagram in Figure 1, it can be explained that through the process of identifying journal articles through an online-based journal database, namely Google Scholar, a total of 144 journal articles were obtained. The screening phase found a total of 7

articles with the same title so they were issued. In the eligibility stage, 127 articles were found with titles and abstracts that did not match the research topic, were not available in full-text form, and were not in accordance with the scope of the research, so they were excluded. At the determination stage, 10 journal articles were determined to be reviewed.

3.   RESULTS AND DISCUSSION

There are 10 journal articles that will be further analyzed in this literature review. The journal articles are grouped based on the scope of their discussion so that two focus articles are obtained related to the topic of applying MAKP Modular to patient satisfaction in health services.

Tabel 1. Summary of The Literature Review

No.	Penulis	Judul	Tujuan	Metode	Hasil	Kesimpulan
1.	Asriani, Mattalatta, Betan, A. (2016)	The Effect of Implementation of Professional Nursing Practice Model (PNPM) to Standards of Nursing Care and Job Satisfaction of Nurse at Inpatient Room of Bhayangkara Makassar Hospital	Understanding how satisfied nurses were with their jobs before and after PNPM was implemented, as well as how well nursing care standards were followed before and after PNPM was implemented.	Quasi-experimental research was conducted using a pre-post test questionnaire method with 60 respondents.	There is a significant effect on nurse job satisfaction and quality of implementation of nursing care standards before and after the implementation of PNPM.	Both before and after the implementation of PNPM, nurses' levels of job satisfaction differ. Before and after the implementation of PNPM, the quality of the implementation of nursing care standards is affected.
2.	Luan, M. G., Prayogi, A. S., Badiah, A., Murwani, A. (2018)	The Correlation of Nurse Performance and Patient Satisfaction in the Inpatient Room of dr Soetarto Hospital	Examine the relationship between nurse performance and patient satisfaction in the dr. soetarto hospital inpatient room	Quantitative descriptive correlation.	There is a huge connection between nurture execution and client fulfillment, and better medical caretaker execution will likewise increment client fulfillment.	At Dr. Soetarto Hospital, there is a significant correlation between nurse performance and client satisfaction.
3.	Andung, P. J. R., Sudiwanti,	Description of The Nurses Performance	Identify the description of the nurse's	Descriptive research with a sample of	Nurses carry out handover activities well	Overall, the nurse's performance

	N. L. P. E., Maemunah, N. (2017)	in the Implementation of modified MAKP Team-Primary in the Dahlia Room at Umbu Rara Hospital	performance in the implementation of the MAKP modification team primary at Umbu Ara Hospital.	12 nurses. The research was conducted using a questionnaire.	(75%), nurses do conferences well (42%), nurses do post conferences sufficiently (42%), and nurses do nurse rounds with less than 100%, nurses do sufficient discharge planning (50%), nurses do good drug centralization (67%), and nurses do good nursing documentation (67%). Overall, the nurse's performance in applying the team-primer modification MAKP was moderate (58%).	in applying the team-primer modification MAKP was moderate (58%). It is recommended to add more space in future research so that nurses can compare the performance of nurses between rooms that have implemented the primary-team Modified MAKP.
4.	Mendrofah, H. K., Hasibuan, M. T. D. (2021)	Comparison of Team Professional Nursing Care Model and Primary Nursing in Improving the Quality of Nursing Care in Medan City Hospital.	Identify the use of primary and team model MAKP in improving the quality of nursing care.	Quantitative research with a comparative design. Data was collected using the PAQS-ACV questionnaire to assess the quality of nursing care.	There were significant differences in the quality of nursing care in the team model and primary model. The results showed that nursing care with the primary model provided better quality nursing care	Suggested for hospitals or health care settings to apply the primary model of professional nursing care methods to improve the quality of nursing care to patients.

						than the team model.
5.	Panjaitan, L. S. R., Maurung, I., Sulastri. (2015)	Differences in the completeness of the documentation between the model method and the team method at Mitra Husada Pringsewu Hospital	Identify the differences in the completeness of the documentation between the model method and the team method at Mitra Husada Pringsewu Hospital.	The research is comparative by auditing 230 documentation.	There are significant differences in the completeness of nursing documentation between the modular method and the team method.	It is recommended that the management of Mitra Husada Pringsewu Hospital improve management by carrying out employment calculations, so that there is a balance between the existing nursing staff and the average number of patients and the nurse's workload does not become high, supervises, and provides rewards for rooms that are performing well.
6.	Sofiaun, Fitryasari, R., Ahsan. (2022)	Development of a Modular MAK Model Based on Nurse Work Productivity in Improving Patient Satisfaction	Constructing a modular MAKP model that is based on the productivity of nurses' work in enhancing patient satisfaction.	There were two phases to the research. The first stage employs a cross-sectional approach and an explanatory design. There are 112 nurses in the area.	The variable organizational characteristics, individual characteristics, job features, and work productivity-based modular MAKP that had a significant impact on unsatisfactory	By improving job characteristics, it is possible to achieve optimal patient satisfaction.

				Through FGD, the second stage involved expert discussion.	client satisfaction were the outcomes of Stage 1. The module concept, or the modular MAKP concept based on nurse work productivity, was obtained in Stage 2.	
7.	Indrawati, E & Erlena. (2023)	Application of Team Model Nursing Care Management and Primary Model to the Quality of Nursing Care	Learn the viability of the execution of group model nursing care the executives and the essential model on the nature of nursing care in the twofold room of Karawang Region Emergency clinic.	Group-based quasi-experimental research with a pre-post test. There are 104 respondents in the research samples.	The primary method group and the team method group had significant differences.	The application of the team method and the primary method affects improving the quality of nursing services.
8.	Suryamin & Reinnamah (2017)	Analysis of the nurse satisfaction correlation regarding the professional nursing care method (MAKP) of the primary team (modified) with the performance of nurses in the Jasmine room of Mardi Waluyo Hospital.	Define the relationship between the nurse's performance and the professional nursing care method (MAKP) of the primary team and the nurse's level of satisfaction.	Correlation research with data collection techniques in the form of satisfaction and performance questionnaires. A sample of 14 nurses at Mardi Waluyo Hospital.	The majority of nurses (78.6%) were pleased with the outcome. 36% of nurses have very good performance, while 57% of nurses perform well. Hospital performance is negatively correlated with nurse satisfaction.	In hospitals, MAKP implementation has the potential to raise the standard of nursing care. One of the evaluation criteria for hospital accreditation, particularly for nursing services, is suggested to be the MAKP application.

9.	Dion, Hyronimus, Fernande, Paun, R. (2019)	The relationship between the implementation of the primary-team MAKP and the quality of nursing services in the inpatient room of dr Ben Mboi Ruteng Hospital	Analyzing the relationship between the quality of nursing care provided in the RSUD inpatient room and the implementation of the primary-team MAKP	Cross-sectional descriptive-analytic research design was utilized.	The results indicated that the Primary-Team MAKP implementation was satisfactory (86.2%), and the majority of respondents rated the rapport room's care services as satisfactory (72%). In view of the consequences of measurable tests, it was observed that there was a connection between the execution of the Tim-Preliminary MAKP and the nature of nursing administrations in the Tear room, at Dr. Ruteng Emergency clinic.	The quality of nursing care in the RIP room at Dr. Ruteng Hospital was found to be correlated with the implementation of the Primary-Team MAKP. Because the team's MAKP is more in line with the backgrounds of nurses with DIII education, it is recommended to maintain the quality of service; boosting institutional commitment to nursing care implementation; enhance the educational credentials of nurses, particularly primary nurses and heads of rooms, by providing opportunities for further education at the Nurses level; keep up with the nature of administration to patients

					who are being dealt with.
10.	Oktaviana, R., Lestari, I., Ibnu, F., Jainurakhma, J. (2022)	Application of professional nursing care methods: analysis of motivation to optimize Nurse performance	At RSIA Ferina Surabaya, examining the connection between MAKP implementation and nurse performance motivation.	Non-experimental research with a total of 14 nurses as respondents.	The consequences of the review show that there is a connection between's work inspiration and the utilization of expert nursing care techniques with a positive relationship. Motivation at work is essential for aircraft performance and MAKP implementation.	To ensure that professional team model nursing care can be carried out to its full potential and that patients are satisfied with the services they receive, there needs to be a breakthrough and special attention paid by management to increasing the motivation of nurses.

The Professional Nursing Care Model (MAKP) is a service guideline that is compiled and mutually agreed upon at a practice level to achieve the goals set (Asriani & Mattakatta, Abubakar., 2016). The implementation of MAKP in nursing services is also determined by the job satisfaction of nurses so that MAKP is optimally operated. Based on research by Asriani et al., (2016) stated that 55 people (91.7%) of nurses were satisfied with their work after the MAKP was determined compared to before the implementation of the MAKP, namely 43 people (71.7%). According to Imelda (2011), nurses' competence and performance in providing patient care increased following the implementation of MAKP. The standard of nursing care will be better implemented if nurses perform better. In view of examination by Asriani et al., (2016) compared to 44 patients (73.3%) prior to MAKP's implementation, 56 patients (93.3%) experienced an improvement in the quality of nursing care standards.

MAKP Modular is a combination of the team model and the primary model. There are several factors behind the merging of the two development models. The primary construction model is not used in its entirety because nurses must have an undergraduate education background (bachelor of nurse) or equivalent. Meanwhile, the team model can not be used entirely due to the fragmentations of the responsibility into various teams. The deficiencies of the two models are overcome by merging the two models to create an optimal professional nursing care model. Inequality in the education level of nurses in health services is also the background for the implementation of the MAKP Modular. Most of the education of nurses in health services is Diploma and Vocational of Nursing so guidance is needed regarding the provision of nursing care by the team leader who has a Nurse education background (Sitorus R, 2006).

Based on the findings of Andung et al (2017), In regards to the description of nurse performance in the MAKP Modular application, it was stated that the average performance of

nurses was in the sufficient category, with 58%. Based on the research of Andung et al., (2017) Modular MAKP activities have not been implemented optimally. This non-maximum could be seen from MAKP activities such as pre and post-conferences which are executed all the time according to the schedule and are carried out only when there are certain conditions, such as patients who are treated with the total care classification. Loss rounds are also not done every day as they should be. Pre-post conferences are not held every day because some nurses, namely as many as 4 (four) people (33%) pay little attention to patient problems. This can be circumvented by making preparations for things that will be encountered in the field and providing opportunities for discussions between nurses about the patient's condition. To increase the intensity of the pre-post conference, activities should be carried out before providing nursing care with a time of 10 to 15 minutes, the topics discussed must be limited, only including the patient's condition, action plan, and important data that needs to be added. Based on the research of Andung et al., (2017) recovery rounds have not been carried out optimally by 12 nurses (100%). To increase the intensity of the round of assault activities, it is necessary to prepare all nurses to carry out round activities by applying at least 1 (one) case before the round is carried out and giving informed consent to families and clients. Rounds also require an explanation at the beginning of the activity to the client which focuses on the problem of concern and the action plan to be carried out (Magfuri, 2015).

Based on research by Panjaitan et al., (2015) it is stated that there were significant differences in the completeness of documentation between nurses who worked with the modular method and the team method. The results showed that the average completeness of nursing documentation in the modular method was 85.75 and the team method was 90.89. Research by Panjaitan et al., (2015) identified that the workload of nurses was a factor causing incomplete nursing documentation. In addition, the motivation of nurses in documenting nursing care affects the completeness of nurse documentation. In the modular method, completing nursing documentation is done individually. In addition to workload and motivation, there are factors in the number of workers, work environment, lack of time, and lack of supervision from the management of health services (Widyaningtyas, 2012). According to Musiana and Manurung (2011), complete nursing documentation could be created with some support, including policies to complete nursing documentation in the available system, availability of nursing documentation formats, supervision of documentation implementation, and nursing documentation training for nurses.

Based on research by Sofiatun et al., (2022) states that the characteristics of nurses which include knowledge, attitudes, and motivation influence the application of MAKP Modular. The results of research by Sofiatun et al., (2022) found that most nurses already know and understand about MAKP Modular. Muryani's research (2019) states that there is a relationship between nurses' knowledge and the application of MAKP. The qualified knowledge of nurses will increase the application of MAKP in the health service. Meanwhile, on the attitude aspect of nurses in the study of Sofiatun et al., (2022) it was found that the majority of nurses had performed nursing care on patient complaints and were guided by existing SOPs (Standard Operational Procedure). The results of research by Sofiatun et al., (2022) also stated that nurses get enough praise and rewards for their achievements, so they feel satisfied with their work environment.

The use of MAKP Secluded fundamentally could make a growing experience between medical caretakers in giving nursing care to patients. Through the sharing of experiences among nurses and the existence of leadership regeneration, the application of the MAKP team facilitates a productive process of collaboration in the provision of nursing services (Pradana dkk., 2022). In the mean time, the utilization of essential MAKP will build the freedom of

medical attendants in completing nursing care. The process of providing nursing care will be more effective and efficient as a result of this process (Dion et al., 2019); Rahmawati dkk., 2021).

Nurses are at the forefront of health services, both in clinics and hospitals. The provision of nursing services is performed through the provision of optimal nursing care (Luan et al., 2018). Nurses have a fundamental role and have a broad impact on the effectiveness, efficiency and quality of health services (Sari dkk., 2022). Nurses play an important role considering the quality of nursing services affects the totality of health services provided to patients (Kurniati & Efendi, 2012). Based on research by Luan et al., (2018) there is a positive correlation between nurse performance and patient satisfaction, with a correlation coefficient of 0.646. This indicates that the better performance of nurses will increase patient satisfaction with health services. Patient satisfaction can be achieved by paying attention to several things including patient complaints, the condition of the patient's physical environment, and the responsiveness of the nurse in identifying the priority needs of the patient (Luan et al., 2018). If the patient feels that the nurse is skilled and competent, the patient will feel comfortable so they have a higher desire to recover. Nurses with good performance will create a cooperative relationship between nurses and patients during the treatment process.

Good performance of nurses will be in line with good implementation of the nursing model in providing nursing care. According to research by Sofiatun et al., (2022), there is a significant effect between MAKP Modular based on work productivity and patient satisfaction. MAKP Modular based on work productivity is defined as a system that includes structure, process, and professional values so that nurses could provide professional nursing care to patients. In this study, MAKP Modular affects patient satisfaction, especially in the aspects of nursing records, methods of providing nursing care, and aspects of personnel which refers to the sufficient number of nurses that leads to increased work productivity. Nurses also have a clear organizational structure and division of work tasks. The combination of the team method and the primary method in this MAKP Modular has resulted in increased success in providing nursing care to patients. Based on research by Sofiatun et al., (2022) on the method of providing nursing care, drug centralization, hand-over, check-in patient, nursing round, supervision, and discharge planning have been performed optimally. Only a small proportion of nurses still feel less than optimal in the method of providing nursing care. This is due to the implementation of the Modular MAKP which is only executed in the morning shift, while on other shifts, they used the team method. This is because there are still many nurses who are at the Diploma level of education, resulting in the Modular MAKP could not be performed in all shifts. Based on research by Sofiatun et al., (2022) on the aspect of nursing records, it was stated that most nurses had arranged the documentation properly, by SOPs, and maintained the security and confidentiality of documentation.

4. CONCLUSION

The implementation of Modular MAKP in the health care system is undertaken by combining the team method and the primary method. The combination of these two methods allows for a more effective and efficient process of nursing care.

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R E S E A R C H **Open Access**

Organic Waste Management Behavior Through Cultivating Black Soldier Fly (BSF)

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Abstract
Waste is our common problem because it is generated every day and throughout the year. People's behavior in throwing rubbish in any place and not caring about the environment can house an unpleasant atmosphere, especially the type of organic waste that causes an unpleasant odor. The aim is to find out the behavior of managing organic waste as feed in cultivating Black Soldier Flies (BSF) in RT 32 Bengkuring. The Qualitative research method with an action research (AR) approach. The research results show that the first stage, here is no organic waste management by residents in RT 32. Second stage, he implementation of socialization and training on BSF/maggot fly cultivation was welcomed by community shops, the government, and local residents. Third phase, most of the mothers were amused or disgusted to see maggots during training because they are shaped like caterpillars, so it is difficult to feed them organic waste. Besides that, it is difficult to get permission from the owners of houses or residential land that has not been used for a long time because their whereabouts are unknown to the owner. In conclusion, the knowledge of residents, community shops, and the local government increased after socialization and practice on how to manage organic waste through cultivating BSF flies. Behavior is low because not all residents dare to see, let alone touch and feed maggots.

Keywords: Organic Waste, Management Behavior, Black Soldier Fly.

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1. INTRODUCTION

Waste is a common issue that we face as it is generated every day and throughout the year. The World Bank, in a September 2019 report, provided data on global waste production. The international financial institution claimed that in 2016, there were 2.01 billion tons of waste accumulated worldwide. Meanwhile, in Indonesia, it was 26 million tons per year (Fitriyah, & Nisa, 2023), making intensive waste management essential, especially for organic waste originating from kitchens, which easily decomposes (Adhikari, et al., 2024; Yulianto, Hasibuan, & Sugiarto, 2023).

Household waste remains a national problem due to its potential to cause air and soil pollution and aesthetic disturbances. Therefore, comprehensive and integrated management is needed from upstream to downstream to benefit health, the environment, and have economic value. One solution for organic waste processing is through Black Soldier Fly (BSF) cultivation (In, et al., 2023), or known as maggot, as BSF/maggot is a type of fly that can consume organic waste, especially from kitchens (Sari, et al., 2022).

In a national seminar on community service and empowerment, training was conducted for members of the waste concern forum in Indramayu district. The participants understood environmental issues and were able to reduce organic waste by 3 kg/day for each BSF enclosure (Ginanti, & Kusuma, 2020). Additionally, waste processing in the form of residual maggots can be used to produce preserved maggots, compost, and other economically valuable products, (Kalidas, Cr M, & Goodsell, ; Susanto, et al., 2022). BSF/maggot cultivation is one method that can be used to reduce organic waste volume. Moreover, BSF/maggots can be sold or used as animal feed, such as for chickens or fish, cultivated by the community (Ananda, Karunasena, & Pearson, 2023), thereby increasing residents' income.

In 2021, the Ministry of Environment and Forestry (KLHK) recorded waste piles in East Kalimantan totaling 733.4 thousand tons/year. Samarinda city was noted as the largest waste-producing city in East Kalimantan, with 212.3 thousand tons/year. The composition was 40% inorganic waste and 60% organic waste. According to the SNI M-36-1991-2003, the waste produced per person per day was 0.7 kg. With a population of 391 people in RT 32 Bengkuring in 2022, the organic waste produced by the residents of Bengkuring RT 32 was 164 kg/day and 1,149.54 kg/week. This shows the importance of intensive and sustainable waste management, so that it can reduce the volume of waste.

Based on initial observations conducted in RT 32 Bengkuring, residents are not consisten in managing organic waste, it has been proven that leftover food waste is thrown into the ditch in front of the house or put in plastic bags, then there are residents who hang it on the fence in front of the house or put in uncovered rubbish bins, so that the rubbish is scattered by cats, rats, and other vectors before the waste carrier comes to pick it up, causing an unpleasant odor. Most residents also utilized their yards for catfish cultivation using tarpaulin ponds or buckets. The catfish produced were sold to groups of women forming joint businesses (kubu) Amanah 32 to be processed into snacks such as fish sticks, frownies, amplangs, and others. Therefore, it is highly relevant to process organic waste into maggot feed, which can subsequently be used as catfish feed. Besides being a solution to reduce organic waste, it can also improve the nutritional quality, especially the protein content, of the catfish cultivated by residents (Andari, Ginting, & Nurdiana, 2021). The research aims to understand the behavior of organic waste management as maggot/BSF feed in RT.32 Bengkuring housing.

2. RESEARCH METHOD

The research method used is qualitative with the Action Research (AR) approach, which aims to facilitate analysis of reinforcing and supporting factors in the formation of organic waste management behavior as BSF/maggot feed in Bengkuring RT 32. Secondary data is from

sub-districts and RTs, while primary data was obtained by interviews in-depth observation and documentation to 4 informants, namely 3 residents and 1 RT head who carried out three stages, namely in the first stage, diagnostic action, namely initial communication about the behavior of the RT 32 community in managing organic waste as BSF/maggot feed. In the second stage of taking action, (research participants) carried out outreach and training on maggot cultivation so that the organic waste produced by residents could be fed to maggots and the maggots themselves could be fed to catfish which residents have been cultivating for a long time. Stage 3, evaluation action, namely evaluating the results of counseling and training carried out through in-depth interviews, observation and documentation. Next, the data is processed and analyzed qualitatively and interpreted, after the data is saturated, conclusions are drawn.
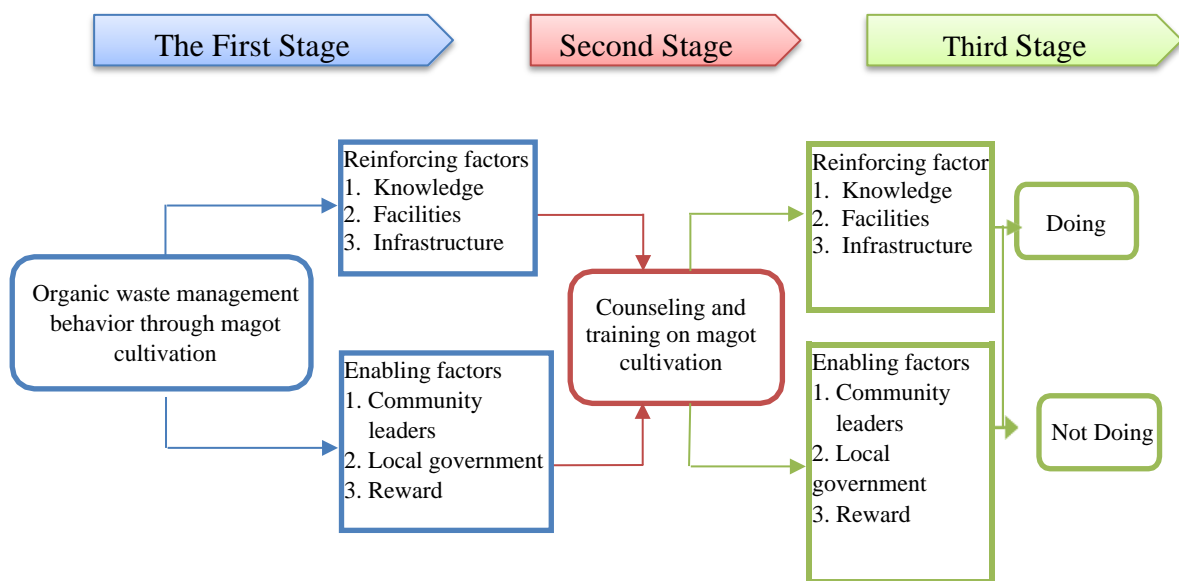
Figure 1. Interview and Observation Organic Waste Management Behavior Through Cultivating Black Soldier Fly (BSF)

3. RESULTS AND DISCUSSION

The first stage, namely *diagnosing action*, based on the results of observation and documentation of characteristics to four informants as follows.

Table 1. Informant Characteristics

No.	Informant Code	Age	Education	Occupation	Gender
1	W.A.S.X	46 year	S1	Private Institution/Residency Head	Man
2	W.A.A.X	23 year	SMA	Teacher/resident	Women
3	W.A.G.X	18 year	SMA	Student/resident	Women
4	W.A.I.X	53 year	S1	Self-employed/resident	Women
5.	W.A.H.S	58 year	S1	Head of Sempaja Timur Village	Women

The results of in-depth interviews with community stores, RT.32 has won the first prize in the *Kampung Sampah* Nilai (salai) competition at the Samarinda City level, and the results of observations also prove that residents are proactive in managing inorganic waste, either by recycling plastic waste or selling it directly to the Amanah 32 Waste Bank. Meanwhile, organic waste from food scraps and vegetable lunches has not been recycled or processed, because they do not know how to manage it, forever food scraps are immediately thrown away so that they do not rot. as follows excerpts from interviews with informants;

Excerpt 1

"I don't know, can organic waste be processed with maggot cultivation? Here, we can only make compost for the organic waste." (W.B.S.3)

Excerpt 2

I don't know, because I've never heard of maggot, what is it, I'm curious" (W.B.I.3).

Based on the data above, informants did not know what BSF or magot were, and all informants admitted that this was the first time they had heard the name magot. Based on the initial observation, the available infrastructure is limited. RT 32 is a residential neighborhood that is densely packed with buildings, but there is still public land such as a large langar yard, greening land and an empty house that has been uninhabited for a long time so that the house is not suitable for habitation and the owner gives permission to be used so that someone also cleans the land.

As for the means to support magot cultivation, residents are willing to prepare it if magot can be profitable and useful for them.

Table 2. Recapitulation The First Stage Organic Waste Management Behavior Through Maggot Before Intervention.

Reinforcing/Supporting Factors	Informant			
	W.A.S.X	**W.A.A.X**	**W.A.G.X**	**W.A.I.X**
Knowledge	Don't know	Don't know	Don't know	Don't know
Facilities	Ready to set up	Ready to set up	Ready to set up	Ready to set up
Infrastructure	Available	Limited	Limited	Limited

Based on the data above, the intervention activities to be carried out are socialization and training on BSF/maggot cultivation and the method of feeding from organic waste, especially food leftovers. The goal is to increase residents' knowledge about BSF/maggot cultivation and feeding from organic waste, specifically food leftovers, as well as the benefits of maggots.

Second stage is the implementation of the intervention, which involves conducting socialization and training on BSF/maggot cultivation and feeding from organic waste. Following meetings with residents and community leaders, it was agreed to hold the training on Tuesday, January 3, 2023, at the badminton court in the Al-Ittihad mosque yard, RT 32, from 9:00 to 11:00.

The topics covered during the training include: a. Understanding organic waste, methods of converting organic waste into maggot feed, b. Explanation of maggots, the process of maggot cultivation, and the equipment and infrastructure needed for maggot cultivation. Many enthusiastic participants attended the training, including residents from other RTs such as RT 30, 31, and 33, as well as the village head, the head of the community empowerment section

(KASI), and staff from East Sepaja sub-district.Third stage, evaluating action. All informants have a good understanding of how to manage organic waste, especially food leftovers, into maggot feed. They also have knowledge of how to cultivate maggots and use them as catfish feed, which economically helps reduce the purchase of expensive catfish feed. The following is an overview of the evaluation results conducted through observation and in-depth interviews.

High
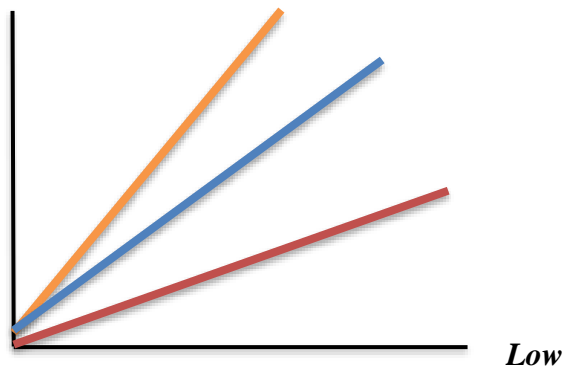
Figure 2. Reinforcing Factors

🟠 Knowledge
🔵 Facilities
🔴 Infrastructure

High
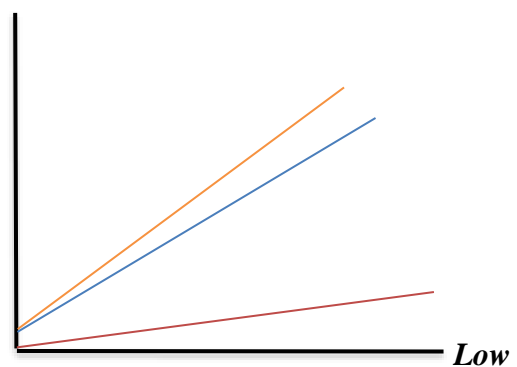
Figure 3. Enabling factors

⬠ Figure Community
⬠ Government
⬠ Reward

Based on the curve chart above, it depicts the conditions of reinforcing factors (knowledge, facilities, and infrastructure). Residents' knowledge, as indicated by the X1 data collection, initially ranged from not knowing what BSF/maggots were, how to feed maggots from organic waste such as food leftovers, to understanding how maggots become catfish feed and their benefits. The results showed that all residents now know and understand the socialization outcomes regarding the processing of organic waste, especially food leftovers, into maggot feed, and the use of maggots as catfish feed. As for facilities, only the head of RT 32 and one community store owner are willing to provide the necessary facilities for maggot cultivation, while two other informants are not yet ready.

Similarly, regarding infrastructure, only the head of RT 32 is prepared and has infrastructure, while the other three informants are still contemplating and find it difficult to obtain infrastructure. This is because the RT 32 area is densely populated and has minimal household yards. However, there is still hope that four long-uninhabited houses can be utilized, and if managed properly, they can prevent becoming breeding grounds for weeds and other rodents.

The condition of supporting factors (community stores, local government, rewards), especially rewards, is relatively weak. This is because the village office has never provided rewards to RTs in its working area, but it will be considered in the future. As per the interview results:

Excerpt 3

> *"We have never provided rewards to RT, whether it's for any form of success, for example, if an RT wins in a village competition throughout Samarinda, whether it's prizes, rewards, and others from DLH or the sub-district, but we will consider it in the future (W.A.H.S)."*

Meanwhile, the role of community stores including the head of RT is quite supportive of any residents interested in maggot cultivation, with one of the aims being to assist in the absorption of organic waste, especially household food leftovers. Their support takes the form of preparing land for use by adult BSF, as adult BSF requires a relatively large area for breeding, such as preparing a cage in the form of a net for adult BSF to live in and go through the mating/egg-bearing phase. If maggots are in the egg, larva, and pupa stages, they can still be placed in containers that do not require a large space. If not permanent, they can be placed in a basin, while for a permanent solution, a cemented area of 1x1 meter or more can be constructed, adjusted according to the weight/quantity of BSF eggs, as evidenced by the following observation and documentation;

Figure 4. Feeding the magot.   **Figure 5.** BSF drum net

Local government support from both the kelurahan and DLH Kecamatan is quite good, because support will be given if the community is ready to do it, and a system is established and agreed upon that will support the continuation of BSF/maggot cultivation without any losses. In fact, the kelurahan is ready to help through probabaya funds if the RT requests any materials needed for BSF/maggot cultivation. As the following interview excerpt shows;

Excerpt 4

> *"Please, Mr. RT, accommodate your citizens and gather who are interested in BSF/maggot cultivation and the need for facilities, then submit a request through the probabaya fund, then we will facilitate and prepare any suggestions needed". W.A.H.S*

As a result of the evaluation, all informants were quite well informed on how to manage organic waste, especially food waste into maggot feed. Likewise, the knowledge of how to cultivate maggot to become catfish feed is economically very helpful in reducing the purchase of expensive catfish feed. The following is a recapitulation of the evaluation results;

Table 3. Recapitulation Second Stage Organic Waste Management Behavior through Maggot Cultivation After Intervention

Reinforcing/supporting factors	Informant			
	W.A.S.X	W.A.A.X	W.A.G.X	W.A.I.X
Knowledge	Knowing well	Knowing well	Knowing well	Knowing well
Facilities	Ready to Set Up	Limited	Limited	Ready to Set Up
Infrastructure	Available	Limited	Available	Limited

DISCUSSION

Garbage has two different sides. First, if it is not properly managed, it poses a risk to the human health that settles around it, especially organic garbage that has an unpleasant smell that can invite many vectors, such as flies, rats, cockroaches, and other rodents. These vectors are an intermediary in infecting humans with diseases such as diarrhea, typhus, sputum, chickenpox, and many other diseases.

So household garbage must be handled seriously, significantly and continuously. To do so needs the support and policy of the local government, the head of RT and the community store so that the citizens are committed in Together to the management of the waste especially organic waste that comes from households.

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So household garbage must be handled seriously, significantly and continuously. To do so needs the support and policy of the local government, the head of RT and the community store so that the citizens are committed in Together to the management of the waste especially organic waste that comes from households.

Knowledge is very synonymous with behavior change, in line with the results of research conducted by CMaxwell-Smith et al, that there is a significant relationship between ability, opportunity and motivation with human action with a stage model approach to behavior change (Maxwell-Smith, et al., 2024). The knowledge of all informants at the initial stage, did not know what BSF was, after the intervention through socialization and training on BSF cultivation and how to feed from organic waste, especially food waste (Nguyen, et al., 2023). All informants understood well and the community store and local government were ready to support through policy, namely holding a competition during the celebration of Indonesia's independence day on August 17.

The results of research conducted by Krishna K et al, that to increase the knowledge of conducting more in-depth training, the activities carried out include making BSF fly cages, attractant media, maggot enlargement media, bioponds, preserved feed products from larvae, and product marketing strategies. The results achieved by participants understand environmental issues and are able to reduce organic waste by 3 kg / day for each participant's cage, make maggot preserved products, and waste processing by-products in the form of kasgot (used maggot) (Kalidas, Cr M, & Goodsell, ; Kim, et al., 2021).

After the intervention was given to informants, reactions showed that most were ready to do it and some, especially the mothers' group, were not ready to do it, because they felt disgusted and ticklish to see BSF larvae, let alone being fed and touched. In contrast to research conducted by L Moussaoui et al, which looked at the perceptions of recyclers of kitchen-sourced waste using government-funded small green bin facilities (PPV). The results showed

a significant relationship between sociodemographic characteristics and the behavior, knowledge and beliefs of sorting organic waste (Moussaoui, et al., 2022; Nguyen, et al., 2023).

The factor of inadequate availability of facilities and infrastructure is due to the fact that the bengkuring housing estate is a densely populated settlement, making it difficult to find land designated for maggot cages. BSF/maggot cultivation is one way of managing organic waste that is environmentally friendly (Rehman, et al., 2023). It efficiently consumes and decomposes a wide range of organic matter, turning it into nutrient-rich compost and high-protein larvae suitable for animal feed or other applications (Mulu, et al., 2023; Mutafela, 2015).

Here is the general life cycle and workings of BSF, starting with the life stages - egg, larva (grub), cocoon, and adult fly. The larval stage is when they consume organic waste. Collection system Organic waste, such as kitchen scraps or agricultural by-products, can be collected in containers suitable for the growth of BSF larvae (Gold, et al., 2018). These containers should allow for drainage, aeration, and protection from predators.

Optimal Conditions BSF larvae thrive in warm and humid environments. Ensure that the waste is moist but not too wet, as excessive moisture can lead to anaerobic conditions and create odors. Feeding the Larvae from Organic waste is put into a container, and the larvae are introduced. They will consume the waste, breaking it down through their digestive system (Rehman, et al., 2023; Reignier, Méchin, & Sarbu, 2021).

Harvesting Compost and Larvae After the feeding period, which varies depending on the conditions and type of waste, adult larvae move away from the food source to pupate (Sari, et al., 2023). Today, they can be harvested for various uses, such as animal feed or compost. Composting waste left in the container, which has been partially decomposed by the larvae, can be used as compost. It is nutrient-rich and beneficial for use in polybags/pots for vegetables or ornamental plants (Sarker, et al., 2024).

Managing the process, regular monitoring and maintenance of the BSF culture system is essential. Adjustments may be needed to optimize larval conditions and ensure efficient waste decomposition (Susanto, et al., 2022). because if it is not efficient, it will cause an unpleasant odor, while the bengkuring housing estate is a densely populated settlement. BSF fly farming for waste management requires attention to hygiene, proper organization and monitoring. It is an effective method that not only reduces organic waste but also produces valuable resources such as compost and protein-rich larvae.

4.   CONCLUSION

Phase 1 (X01), many residents and community stores, and local governments do not know about organic waste management through BSF / maggot cultivation. local residents have not managed organic waste of food/kitchen waste, the results of kitchen waste are directly disposed of. As for facilities and infrastructure based on observations, there is still unused community land, so it can be utilized as maggot cage land. So that RT 32 is suitable if cultivating BSF / maggot flies. Stage 2 (X) The implementation of socialization and training activities on organic waste management through BSF/maggot cultivation went well and received a lively welcome from residents, RT 32 community stores and the local government. Stage 3 (X02) Residents, community stores of RT 32 and the local government have a good understanding of organic waste management through BSF/maggot cultivation. The local government is ready to support if residents are ready to carry out BSF/maggot cultivation, because it will absorb organic waste, especially food waste from household kitchens to the maximum, as well as economic value because maggot becomes catfish feed with high protein value.

ACKNOWLEDGMENT

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R E S E A R C H   **Open Access**

Effect of pH Variations in Eosin Methylene Blue Agar (EMBA) Medium on E. coli Growth

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Abstract
The growth of E. coli is influenced by several factors, including environmental pH. Environmental pH unsuitable for bacterial growth conditions will interfere with the enzyme activity and influence bacterial growth. This study aimed to determine the effect of pH variations (5.3, 5.8, 6.3, 7.3, 7.8, 8.3) in EMBA medium on E. coli growth. The research method used was true experiment post-test-only control design. The samples in this study were suspensions with dilutions of 10-4, 10-5, 10-6, and 10-7, inoculated using the duplo test to EMBA with various pH conditions, so that the total sample size is 48. The results showed that the mean number of E. coli bacteria on EMBA with pH 5.3 was 9.1 x 106 CFU/mL; with pH 5.8 was 9.6 x 106 CFU/mL; with pH 6.3 was 1.2 x 107 CFU/mL; with pH 7.3 was 1.1 x 107 CFU/mL; with pH 7.8 was 9.7 x 106 CFU/mL; and with pH 8.3 was 7.1 x 106 CFU/mL. Growth in positive control showed the mean number 1.4 x 107 CFU/mL; negative control showed no growth of E. coli or other microorganisms. Based on the One-Way ANOVA statistical test with a 95% confidence level, there was no difference in the mean number of E. coli bacteria in the six pH variations of EMBA medium (p-value > 0.05). E. coli bacteria grew best at neutral pH. Its growth decreases in slightly acidic and slightly alkaline pH, but it can still be observed. This allows E. coli to survive in extreme pH. Pathogenic E. coli have developed the potential to live inside the human body. They will experience temporary stress in unfavourable conditions before finally adapting. The advice for future researchers is to test the effect of pH on E. coli growth by using other E. coli growth media or with a wider range of pH (more acidic and more basic). It is also recommended to conduct further research about the effect of various environmental conditions such as temperature, nutrients, and others on bacterial growth.

Keywords: E. coli, EMBA, pH Variations.

1. **INTRODUCTION**

E. coli are bacteria commonly found in the environment, food, and the intestines of humans and animals. *E. coli* is a large and diverse group of bacteria. Most types of *E. coli* are harmless, but some pathogenic ones can infect humans. These pathogenic *E. coli* can produce and release toxins that cause disease (Rizky et al., 2021). The growth of *E. coli* is influenced by several factors, one of which is physical factors, including pH, temperature, oxygen, humidity, and light (Arivo & Annissatussholeh, 2017). In addition, bacteria also need nutrients to grow. The nutrients needed for *E. coli* growth are carbon, hydrogen, nitrogen, phosphorus, sulfur, vitamins, water, and others. These nutrients can be met and must be present in the media for bacteria growth. Synthetic media for the growth of *E. coli* can be solid or liquid media, such as eosin methylene blue agar (EMBA), mac-Conkey agar (MCA), endo agar (EA), nutrient agar (NA), triple sugar iron agar (TSIA), indol medium, sugars medium, and another medium for *E. coli* growth (Arianda, 2016).

The media used for bacterial growth depends on the purpose or need, whether differential media, enriched media, or selective media. Selective media for *E. coli* growth can be used for endo agar/endo's medium (EA) and eosin methylene blue agar (EMBA). EMBA is a selective medium because the methylene blue contained in it can inhibit the growth of gram-positive bacteria. Sugars contained in the media are lactose and sucrose, which are substrates that can be fermented by most gram-negative bacteria, especially coliform bacteria. The presence of lactose and sucrose also aims to distinguish between coliform bacteria that can ferment sucrose faster than lactose and those that cannot ferment sucrose (Juwita et al., 2014).

Besides nutrients, the pH value of the growth medium is also an essential factor in bacterial growth. pH is the number of Hydrogen ion (H^+) concentrations expressing the acidity level and basicity in a solution (Ngafifuddin et al., 2017). There are three groups of bacteria based on the optimum pH value of their growth, neutrophil bacteria that grow optimally at a pH of neutral range (pH 7), acidophil bacteria that grow at a pH of less than 5.55, and alkaliphilic bacteria that grow optimally at a pH between 8-10.5 (Isnawati & Trimulyono, 2018). *E. coli* can grow at pH 4.5 - 9 (Ratzke & Gore, 2018). These bacteria belong to neutrophilic bacteria that grow optimally at a neutral pH range of 6.5 - 7.5 depending on the temperature (Philip et al., 2018). The optimum pH condition for *E. coli* growth currently widely known is the pH condition in the laboratory. *E. coli* is a bacteria that can survive and proliferate in a wide range of environmental conditions. *E. coli* will undergo brief stress when placed in an environment that does not support its growth but will adapt. Its ability to adapt to pH levels other than its optimum growth pH enables it to invade the human body. Creating slightly acidic to slightly alkaline pH fluctuations in *E. coli* growth medium can reflect different conditions in the human body or the external environment, aiding knowledge of how *E. coli* bacteria adapt to varied pH situations.

This study aimed to determine the effect of pH variations (5.3; 5.8; 6.3; 7.3; 7.8; 8.3) in EMBA selective medium on *E. coli* growth. This research tests the hypothesis that there is a difference in the mean number of *E. coli* bacteria in the six pH variations of the EMBA medium, with a confidence level of 95%.

The benefit of this research is to increase understanding related to environmental conditions that can prevent the growth of *E. coli*, such as in highly acidic and alkaline environments. So that, diseases can be prevented and controlled. The study results can also add information for medical laboratory technologists (ATLM) regarding the determination of pH in *E. coli* growth media and support identifying *E. coli* on agar media. Additionally, the study's findings can be used as reference for the development of new antibiotics.

2. RESEARCH METHOD

The research design used was a true experiment post-test-only control design. This study consisted of two groups: the treatment and control groups. The treatment group consisted of EMBA medium that received a pH intervention. In contrast, the control group consisted of EMBA medium that did not get a pH intervention (the pH utilized was the factory pH of 6.8). The population in this study was a 0.5 McFarland *E. coli* suspension, and the samples used were part of a serially diluted *E. coli* suspension. The samples used were suspensions with dilutions of 10^{-4}, 10^{-5}, 10^{-6}, and 10^{-7}, inoculated using the duplo test to EMBA with various pH conditions, so that the total sample size is 48. Sampling using purposive sampling technique with inclusion criteria is *E. coli* colonies that grow on EMBA medium with pH variations of 5.3, 5.8, 6.3, 7.3, 7.8, 8.3 and exclusion criteria is *E. Coli* colonies that grow on EMBA medium with six pH variations are accompanied by fungal growth or other contaminants.

From May to June 2023, data were collected in the bacteriology laboratory of the medical laboratory technology department of the Jakarta III of Health Polytechnic, Ministry of Health. Data were collected by preparing the instruments, materials, chemicals, and growth media. Furthermore, preparation of test bacteria such as making *E. coli* stock on NA medium, bacterial rejuvenation, identification of *E. coli* purity with IMViC test, gram staining, making *E. coli* 0.5 McFarland suspension, and serial dilution of *E. coli* 0.5 McFarland suspension. Test materials were prepared by making an EMBA medium with six pH variations. Making EMBA medium pH 5.3, 5.8, 6.3 was performed by adding an acidic solution (HCl) to the initial media. EMBA medium with pH 7.3, 7.8, and 8.3 was made by adding a basic solution (NaOH) to the initial media. *E. coli* inoculation on EMBA with six pH variations was conducted in duplicate (duplo) with the pour plate inoculation technique. The media was then incubated at 37°C for 2x24 hours.

Data analysis using univariate and bivariate analyses. Bivariate analysis was carried out using the One-Way ANOVA statistical test, with the data being normally distributed and homogeneous. Data normality test using The Saphiro-Wilk test.

This study has passed the ethical review with a statement of ethical feasibility of research issued by the Health Research Ethics Commission (KEPK) of Prof. Dr. Hamka Muhammadiyah University on May 24, 2023, with No: 03/23.05/02544.

3. RESULTS AND DISCUSSION

The results of reading the number of *E. coli* growth with variations in pH on EMBA medium can be seen in Table 1.

Table 1. Distribution of *E. coli* number on EMBA medium with pH variations

pH	Dilution	Mean number of *E. coli* (CFU/mL)
5,3	10^{-5}	$9,1 \times 10^6$
	Media control	0
5,8	10^{-5}	$9,6 \times 10^6$
	Media control	0
6,3	10^{-5}	$1,2 \times 10^7$
	Media control	0
Positive control (Factory pH = 6,8)	10^{-5}	$1,4 \times 10^7$
	Media control	0
7,3	10^{-5}	$1,1 \times 10^7$
	Media control	0

pH	Dilution	Mean number of *E. coli* (CFU/mL)
7,8	10^{-5}	$9,7 \times 10^6$
	Media control	0
8,3	10^{-5}	$7,1 \times 10^6$
	Media control	0

Table 1 shows that the amount of *E. coli* growth differs in the six pH groups of EMBA medium and the control group. The highest change was in pH 6.3, with a mean of 1.2×10^7 CFU/mL, followed by pH 7.3, which had a mean of 1.1×10^7 CFU/mL. The amount of growth decreased gradually as the pH increased and decreased from neutral pH. However, the most apparent germs decreased at a slightly alkaline pH (8.3) with a mean number of 7.1×10^6 CFU/mL. While at a slightly acidic pH (5.3), the mean number was 9.1×10^6 CFU/mL. The positive control group with a factory pH of 6.8 (neutral) showed the most fertile growth among the treatment groups, with a mean of 1.4×10^7 CFU/mL.

Table 2. Descriptive Statistics of *E. coli* Colonies Number based on pH Variations

pH	Min	Mean	Max	Range	Std deviation
5.3	0	113	356	356	152
5.8	0	123	396	396	168
6.3	0	144	444	444	189
Positive Control	2	162	504	502	211
7.3	0	134	424	424	180
7.8	0	126	400	400	171
8.3	1	112	376	375	159

Table 2 shows the descriptive statistics of *E. coli* colonies, including mean value, minimum, maximum, range, and standard deviation. The highest number of colony was observed at pH 6.3, while the lowest number of colony was observed at pH 8.3. The positive control shows the best growth of *E. coli*, exhibiting the highest colony count among all pH variations.

Table 3. *One-Way ANOVA* Statistical Analysis

	dF	Mean Square	F	Sig.
Between Groups	6	0,210	0,250	0,957

Table 3 shows the analysis of the number of *E. coli* growth with six pH variations of EMBA medium using the One-Way ANOVA statistical test. The result obtained was the value of P = 0.957 (P> 0.05), which means that at the 95% confidence level, there was no significant difference or there was no difference in the number of *E. coli* bacteria in the six pH variations of the EMBA medium.

a.   Frequency Distribution of pH Variation in EMBA Medium on *E. coli* growth

The study found that *E. coli* bacteria grew best at a neutral pH. This can be seen from the high number of *E. coli* growth in the control group. The pH value in the positive control was 6.8 (neutral). The growth decreased gradually at increasingly acidic and increasingly alkaline pH. However, the most negligible change occurs at alkaline pH (8.3). This is in line with Thornton et al. (2018) research which stated that *E. coli* growth is higher at acidic urine pH than alkaline urine, but the highest growth is at neutral pH. *E. coli* is more resistant to slightly

acidic pH than slightly alkaline pH because, in alkaline conditions, bacterial cells require higher energy to maintain the balance of their condition, which results in cells losing protons (AlRabiah et al., 2018).

This study used EMBA as a selective medium for *E. coli* growth. EMBA medium was chosen because it is a selective media that can quickly and accurately differentiate *E. coli* from other gram-negative bacteria (Jamrin et al., 2022). The samples used were *E. coli* suspensions with dilutions of 10^{-4}, 10^{-5}, 10^{-6}, and 10^{-7}. However, after research, the number of representative colonies was at a dilution of 10^{-5}, with the number of colony growth between 30-300 in line with the standard plate count (SPC). According to Fardiaz (2013), counting colonies and writing germ numbers refers to the standard plate count (SPC), with the Petri dish chosen to have a colony count of 30-300. In dilutions that produced less than 30 colonies, the results were presented as fewer than 30 colonies multiplied by the dilution factor, with the actual number in parenthesis. In dilutions that produced more than 300 colonies, the results were reported as more than 300 colonies multiplied by the dilution factor, with the actual number included in parentheses (Purnamasari et al., 2013).

This study used sterile 0.9% NaCl as media control or negative control. The use of negative control aimed to ensure that the *E. coli* that grows does come from samples produced on EMBA medium with pH variations and not due to contamination or other factors that may be present in EMBA medium. The results on negative control showed no growth of *E. coli* or other microorganisms.

b.   Effect of pH Variation in EMBA Medium on E. coli Growth

Based on the One-Way ANOVA statistical test, at the 95% confidence level, there was no significant difference in the number of *E. coli* bacteria in the six pH variations of EMBA medium. According to Isnawati & Trimulyono (2018), most bacteria are neutrophil bacteria, including *E. coli*. They grow well at a pH range of one or two units from neutral pH of 7. Some microorganisms can survive and adapt to small changes in environmental pH (Guan & Liu, 2020). According to research by Martín-Gutiérrez et al. (2016), *E. coli* can grow at pH 5, 6, and 7 in urine. Although urine is acidic such as at pH 5, the growth of *E. coli* is not too disturbed, which indicates that the bacteria can adapt well to slightly acidic conditions. However, compared to Mueller-Hinton (MH) media, the growth in urine is relatively low. This is due to the lack of nutrients in the urine.

In addition to pH value, growth media is a crucial component for bacterial growth since it contains nutrients that can encourage bacterial growth. The dyes eosin and methylene blue in Eosin Methylene Blue Agar (EMBA) can suppress the growth of gram-positive bacteria. As carbon sources, this medium contains sucrose and lactose, which distinguishes gram-negative bacteria based on their ability to ferment lactose. Eosin and methylene blue dyes can identify lactose fermentors from non-lactose fermentor bacteria found in the colour of the colonies generated (Widinugroho & Asri, 2021). Levine modified this medium 1918 by reducing the sucrose content and increasing the lactose concentration (Zimbro, 2009).

Lactose sugar is used as a nutrition and carbon source by *E. coli* in an EMBA medium. *E. coli* can ferment lactose because *E. coli* has the β-galactosidase enzyme, which is triggered by lactose. Lactose in the media can activate the lac operon and produce the enzyme expression. Lactose can be broken down into glucose and galactose by the β-galactosidase enzyme. If lactose concentration in the medium decreases, so will the concentration of β-galactosidase enzyme, which may have a detrimental impact on the growth of *E. coli* (Seager & Slabaugh, 2010).

The findings from this research are consistent with previous research by Arivo & Annissatussholeh (2017) , which used Nutrient Broth (NB) as growth medium with a pH range of 3, 5, 7, and 9. It indicates that *E. coli* grow best at neutral pH (7), while growth decreases at pH 3, 5, and 9. The measurements on NB media with neutral pH (7) showed high absorbance values, indicating a significant growth of *E. coli* at that pH. Meanwhile, low absorbance values were obtained at other pH levels (3, 5, 9), indicating minimal growth of *E. coli*.

No significant differences in bacteria numbers in the six pH variations of EMBA medium could occur because the selection of the pH range was still relatively narrow with many pH variations. Hence, the differences between variations were slight. In addition, the selected pH variations have not reached extreme pH. Small differences in pH in EMBA medium might not significantly affect the amount of *E. coli* growth because the content of this media was focused on identifying gram-negative bacteria based on their ability to ferment lactose seen from the colour produced by colonies. *E. coli*, a bacterium that can ferment lactose quickly, will produce greenish colonies with a metallic sheen when exposed to light, and the colony centre is blue-black. Bacteria that ferment lactose slowly will produce pink colonies with a dark centre and bacteria that cannot ferment lactose will be transparently coloured (Sophian, 2022).

At the time of observation, the effect of pH variation was also seen in the morphology of *E. coli* colonies. At a slightly acidic pH, *E. coli* colonies gave a paler colour when compared to the optimal pH. The colour difference might occur due to decreased enzyme activity, one of which was the β-galactosidase enzyme. The optimum pH range for the β-galactosidase enzyme to work was 6-8 (Sun et al., 2018). The decrease in enzyme activity due to small changes in the environmental pH (slightly below or above its optimal pH) was caused by changes in the ionic state of the enzyme and often also the ionic form of the substrate. At a specific pH, enzyme denaturation might occur, resulting in a steady decline in enzyme activity (Khusniati et al., 2015). A decrease in β-galactosidase enzyme activity can hinder the lactose breakdown, requiring a more extended incubation period for *E. coli* growth in an environment with a pH slightly outside the optimum pH range.

Most *E. coli* are non-pathogenic bacteria that are beneficial to their hosts. However, some specific strains, like bacteria of fecal origin, can be dangerous to health. These strains have developed the potential to live inside the human body. Pathogenic *E. coli* is a major problem for water, food industries, human health, and the general environment. Once *E. coli* is released into the environment through fecal deposition, it is considered a fecal indicator for assessing water quality. Contamination of food and water sources with pathogenic bacteria is a major cause of diseases such as diarrhea, typhoid fever, UTIs, and others. Therefore, monitoring environmental conditions regarding *E. coli* strains is important for disease prevention and control, and also for the development of new antibiotics. Additionally, the interaction between *E. coli* and the environment can be understood in depth, opening up opportunities for further research in microbiology and related fields (Razmi et al., 2023).

This study has limitations, as the pH range used only consists of six types of pH, with the highest and lowest pH values not yet reaching the extremes. Additionally, to collect data on the number of *E. coli*, this study only used EMBA as the growth medium. Meanwhile, it is highly probable that different effects may occur when using other growth media. Therefore, further research is necessary to gain a better understanding of the growth condition of *E. coli*. Future studies could involve a wider pH range and consider the use of either the same or different media. It is also recommended to conduct further research about the effect of temperature, nutrients, or other environmental conditions on bacterial growth.

4. CONCLUSION

Regarding the result of this study, statistically, there was no significant difference in the number of E. coli bacteria between pH variations in EMBA medium, with a p-value of 0.957 (p-value > 0.05). Nevertheless, the differences can still be observed in the morphology of colonies. Future studies could enhance this research by using a wider range of pH, perhaps extending to extreme pH levels. Future researchers could also use more selective media for E. coli growth. To increase the understanding of bacterial interactions with the environment, it is also recommended to conduct further research about the effect of various environmental conditions such as temperature, nutrients, and others on bacterial growth.

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R E S E A R C H   **Open Access**

Trauma-Focused Cognitive Behavioral Therapy (TF-CBT) in Victims of Sexual Violence Who Experience Trauma: A Systematic Review

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Abstract
Incidents of sexual violence are like an iceberg phenomenon and continue to increase every year. However, this increase is inversely proportional to the rehabilitative efforts provided for victims of sexual violence. The impact of sexual violence is trauma that makes the victim feel helpless. Trauma-Focused Cognitive Behavior Therapy (TF-CBT) is the therapy of choice to treat these impacts. This systematic review aims to determine the implementation and benefits of TF-CBT for trauma victims of sexual violence. The search used seven databases: Scopus, Sage Journals, ScienceDirect, ProQuest, PubMed, Clinical Key, and EBSCOhost. The research design used in the selected articles was three with RCTs, 5 with Quasy experiments, and 2 with cohorts. Selection is based on the criteria of article publication time in the last ten years, providing full text in English. The symptoms measured in trauma cases are PTSD, post-traumatic symptoms, mental problems such as depression, suicide attempts, and behavioral problems. The results showed that TF-CBT positively influenced all of these symptoms. Implementing TF-CBT also involves the role of parents and modifications with culturally sensitive principles. TF-CBT can reduce trauma symptoms. It is hoped that TF-CBT can be used in other trauma cases and apply modification principles that previous researchers have carried out by being culturally sensitive and involving the role of parents.

Keywords: Behavioral Therapy, Sexual Violence, Trauma.

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1. INTRODUCTION

Sexual harassment and violence are still a complex phenomenon in Indonesia and can be seen from various perspectives. Incidents of sexual violence are like an iceberg phenomenon. The increase in incidents of violence occurring in society is inversely proportional to the rehabilitative efforts provided for victims of sexual violence. Real-time data from the Indonesian Ministry of Women's Empowerment and Child Protection (Kemenpppa) dated 6 September 2023 shows that there were 1,364 victims of violence against children aged 0-5 years, 3,953 victims aged 6-12 years, 6,802 victims aged 13-17 years, 18-24 years old as many as 2,216, 7,907 cases of sexual violence were reported, and 1,300 victims received social rehabilitation services (4.7%) (Kemenpppa, 2023). Rehabilitation efforts continue to decline yearly; as seen in the Indonesian Ministry of Women's Empowerment and Child Protection report in 2020, rehabilitation efforts were carried out at 10% of the total report; in 2021, it was 12%; in 2022, it was 4.8%; and in 2023, it was 4.7% (Kemenpppa, 2023).

The age group that becomes victims from year to year is most often the adolescent age group 13-17 years, followed by the young adult age group (18-24 years). Incidents of violence in these two age groups were caused by factors of power or strength that controlled the victim. Perpetrators usually have economic and social control, so they often belittle and blame victims by threatening and manipulating social conditions (Videbeck, 2010). Apart from that, the tendency for sexual violence against girls occurs in dating relationships with a high school educational background (Komnas Perempuan 2020).

Acts of sexual violence can harm the victim. The impacts that can arise include negative stigma, rejection, trauma, and even frustration, as well as experiencing mental disorders that require further treatment (Komnas Perempuan, 2020). Deviant behavior that occurs in victims is also one of the negative impacts of this case, such as smoking, drinking, drug use, self-abuse, and suicidal ideation (Mardia, 2018). Sexual violence can have psychological impacts such as Post Traumatic Stress Disorder (PTSD), depression, anxiety, and social isolation. Victims often experience difficulties in the healing process due to social stigma and obstacles in interpersonal relationships (Ramadhani and Nurwati, 2023).

The psychotherapy approach using the Cognitive Behavior Therapy (CBT) method is said to be one of the most effective psychotherapy treatment methods in treating PTSD cases (Saragi and Sitohang, 2023; Subhi, 2021). However, it was found that there were limitations in treating trauma cases with CBT. This limitation is that CBT focuses more on the fear circuit imbalance without treating the negative effects of PTSD (Brown et al., 2018). Untreated negative affect can interfere with cognitive processes, such as narrowing attention to negatively valenced stimuli, processing, and memory that contribute to the success of CBT. In addition, negative affect can also increase rumination of negative autobiographical memories, difficulty considering counterfactuals, reliance on emotional reasoning, and false and negative interpretations of events (Brown et al., 2018). Side effects arising from CBT in cases of PTSD include tension in relationships with family, feeling distressed/negative well-being, and social tension in the work environment (Schermuly-Haupt, Linden, and Rush, 2018). Research shows that other therapies provide a more comprehensive and specific view of trauma cases, namely Trauma-Focused Cognitive Behavioral Therapy (TF-CBT). This therapy is still very little researched and used in Indonesia. Several studies around the world show that TF-CBT can reduce PTSD symptoms in children and adolescents (De Arellano et al. 2014). TF-CBT also has a positive impact on the trauma of sexual violence victims and their families (Caouette et al., 2021).

Therefore, a systematic study of TF-CBT in victims of sexual violence trauma is needed. This study aims to determine the implementation of TF-CBT. This systematic review will also

examine what benefits TF-CBT can provide to victims of sexual violence and how TF-CBT can provide benefits to victims of sexual violence.

2.   RESEARCH METHOD

The method used in this research is a systematic review. Searches were carried out on seven electronic databases, namely Scopus, Sage Journals, Science Direct, ProQuest, PubMed, Clinical Key, and EBSCO, since October 2023. The keywords used based on PIO (Population, Intervention, and Outcome) were Sexual abuse victim AND TF-CBT AND Traumatic. The number of articles obtained at the start of the search was 2103. Then, the articles were screened using the following criteria: publication time of the article from 2013-2023, a research article, and full text were available, so 24 articles were obtained. Furthermore, the content and feasibility were analyzed using the JBI critical appraisal instrument based on the research methods used, and ten articles were obtained that were suitable for analysis. The articles reviewed met the JBI criteria and other criteria, namely: a) research subjects are trauma patients; b) using TF-CBT intervention; and c) Explaining the results of each variable studied.

All articles that had been analyzed for suitability using the research criticism instrument were then analyzed further by reading the contents of each article in full and grouping them into several of the same variables studied with different results. Before conducting the study, the author used a brief analysis from PRISMA.

3.   RESULTS AND DISCUSSION

Ten articles were included in this systematic review process. The research method was a quasi-experiment with five articles, a cohort with two articles, and an RCT with three articles. From this analysis, it was found that TF-CBT can help overcome trauma and its symptoms. TF-CBT is effective in reducing PTSD ($p=0.04$) (Caouette et al., 2021); ($p=0.001$) (Cabrera et al. 2020); ($p=0.05$) (Jensen et al. 2022). TF-CBT also affects Posttraumatic Symptoms ($p=0.03$) (Hultmann, Broberg, and Axberg, 2023); ($d=0.723$) (Unterhitzenberger, Sachser, and Rosner, 2020); ($p=0.001$) (Hébert and Daignault, 2015). TF-CBT was proven to have a positive impact on mental problems ($p=0.001$); Strengths and Difficulties Questionnaire ($p=0.01$) (Hultmann et al., 2023). Other mental problems that this therapy can positively influence are Depression ($p=0.05$) (Newman et al., 2018) ($p=0.001$) (O'callaghan et al., 2013), Suicide attempt ($p=0.01$) (Newman et al., 2018), and psychological distress (Hébert and Amédée, 2020). Behavioral problems as a result of trauma also had a negative effect from TF-CBT ($p=0.000$) (Hébert and Amédée, 2020); ($p=0.01$) (O'callaghan et al., 2013).
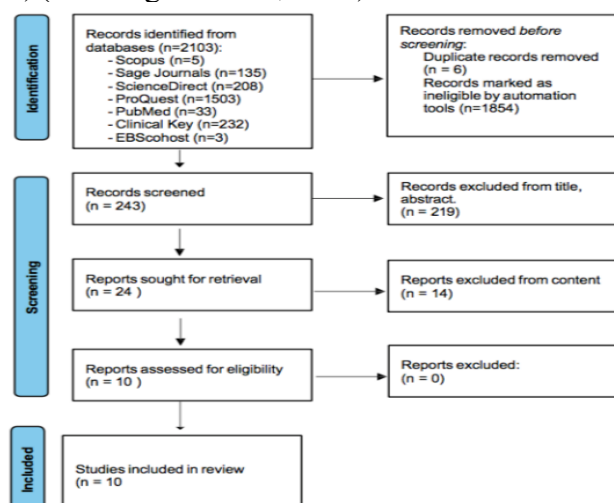
Diagram 1. PRISMA Diagram (Page et al., 2021)

Table 1. Journals Based on Inclusion Criteria

Writer/Year	Study Design	Samples	Intervention	Findings
Justine Caouette; Martine H´ebert; Chantal Cyr; and Laetitia M´elissande Am´ed´ee (2021) (Caouette et al. 2021)	Pilot study pre-post test	• The research sample consisted of 33 child victims of Sexual abuse (SA) at The Child Advocacy Center (CAC) in Montreal, Quebec, Canada, and Caregivers who were not perpetrators of SA: mother (69.7%), father (15.2%), grandmother or foster mother (15.1%).	TF-CBT with ten session and AVI intervention involving recording parent and child interactions in each session for 10 minutes, which was then evaluated and given positive reinforcement by the therapist. The following week, video feedback from clinical staff was provided with an additional 30 minutes of TF-CBT sessions.	The results showed that there was a reduction in children's internalizing (p < .01) and dissociative symptoms (p < .05), as well as maternal psychological distress (p= .05) and post-traumatic symptoms (p= .04) after the intervention. This study also shows that this combined therapy can be recommended as a therapy to promote the recovery of sexually abused children and their non-violent caregivers.
Natalie Cabrera; Gavin Moffitt; Rajeev Jairam; and Giles Barton (2020) (Cabrera et al. 2020)	An uncontrolled open trial providing	• A sample of 15 people (11-17 years) with a diagnosis of PTSD in the tertiary adolescent acute care unit in the South Western Sydney Local Health District (SWSLHD), New South Wales (NSW), Australia.	Nine session of TF-CBT therapy for 28 days.	The results showed that NSESS (severity level of post-traumatic stress symptoms) (mean difference = 15.47, SD = 8.49; t(14) = 7.05, p < 0.001, d = 1.82) and increased significance in global functioning on the CGAS (evaluating global impairment) (mean difference = 29.73, SD = 5.08; t (14) = 22.680, p < 0.001, d=5.85). Both are

				statistically significant positive changes.
Ole Hultmann; Anders G. Broberg; Ulf Axberg (2023) (Hultmann et al. 2023)	Randomized controlled effectiveness trial with three assessment points	• A sample of 89 children, aged 5 to 17 years, with symptoms of severe trauma participated with their nonoffending caregivers in a randomized controlled trial (RCT) comparing TF-CBT and eTAU.	Trauma-focused cognitive behavioral therapy (TF-CBT) with 8-20 sessions and enhanced treatment as usual (eTAU) in children and adolescents exposed to family violence and receiving mental health services.	Results showed child, parent, and clinician reports showed statistically significant reductions in trauma and other mental health symptoms among children in the TF-CBT and eTAU groups, with no statistically significant differences between groups. Trauma symptoms and other mental health symptoms decreased, with small to moderate effects after 6 and 12 months. However, clinically significant changes in core symptoms were documented in less than half of the sample. Parental self-reported psychiatric symptoms and trauma showed slight decreases in both groups, and there were no differences between groups.
Jan L. Everhart Newmana; John M. Falliganta; Kelli R. Thompson; Michael D. Gomezb; Barry	Pre-post one group test (Experiment)	• Participants were 107 male juveniles who had been adjudicated for criminal offenses and	TF-CBT with approximately 24 sessions	Adolescents who completed treatment experienced a clinically significant reduction in PTSD

R. Burkharta (2018) (Everhart Newman et al. 2018)		referred for treatment to a residential treatment program in a secure facility in a Southeastern state.		symptoms as measured by the UCLA PTSD-RI (frequency of PTSD symptoms occurring during the past month) (p < .001). Relatedly, people who complete treatment experience other positive outcomes. Treatment outcomes include symptom reduction on various clinical scales, BASC (evaluating behavior and self-perception), and MACI (assessing various psychological problems and psychosocial functioning). In summary, this study demonstrated positive feasibility results for successfully implementing TF-CBT with AISB decisions in the RTF setting.
Martine Hébert and Laetitia Mélissande Amédée (2022) (Hébert and Amédée 2020)	Latent class analysis	• The sample used 384 children aged 6 to 14 years (67.2% girls; Mean age: 9.56, SD: 2.11) who sought services after disclosure of sexual abuse at a child advocacy	TF-CBT with 8 sessions (PRACTICE: Psychoeducation and parenting skills, Relaxation techniques, Affective expression and regulation, Cognitive coping, Trauma narrative, In	The results of the study made the most appropriate model out of three classes: Classic PTSD, which reclassified 51% of children; Complex PTSD, which described 23% of children; and Resilient, which described 25% of children. Trauma-

		center in Montreal, Quebec, Canada.	vivo gradual exposure, Conjoint parent-child sessions, and Enhancing safety)	focused therapy was associated with significant reductions in dissociation, internalizing, and externalizing problems in children in all three grades. Trauma-focused therapy was also associated with significant reductions in PTSD symptoms with a larger effect size (d = 0.90; 95%CI: 0.63–1.16) for children classified in the Complex PTSD class.
Tine K. Jensen; Nora Braathub, Marianne Skogbrott Birkeland; Silje Mørup Ormhaug; Ane-Marthe Solheim Skar (2022) (Jensen et al. 2022)	Naturalistic observational study of a clinical	• The sample used 73 of 173 adolescents who met the criteria: exposure to at least one potentially traumatic event, age between 6 and 18 years, and clinically significant posttraumatic stress symptoms (PTSS), defined as a score ≥15 on the Child and Adolescent Trauma Screen -2 (CATS-2)	TF-CBT up to 15 sessions	The results showed that PTSS levels decreased by an average of 1.42 in people living with PTSD and 2.09 in CPTSD sufferers. The significant difference between the two results (difference = −0.66, p = 0.015) indicates that greater changes occurred in adolescents with CPTSD than in adolescents with PTSD. There was a significant reduction in symptoms of disorders in self-organization (DSO). Adolescents with CPTSD had higher pretreatment DSO

				levels than adolescents with PTSD (difference = 6.43, p < 0.001) and a steeper decline in pretreatment DSO levels.
Phyllis Lee and Jason M. Lang (2023) (Lee and Lang 2023)	Retrospective cohort	• The sample consisted of 1,861 children (59% girls, 43% Hispanic, 35% white, and 14% black) aged 3–17 years with a primary diagnosis of PTSD who received outpatient psychotherapy at 25 clinics	TF-CBT and non TF-CBT	Children who received TF-CBT experienced significantly greater improvements in problem severity and functioning than children who received other types of usual care (effect size = 0.21–0.24).
Johanna Unterhitzenberger, Cedric Sachser, Rita Rosner (2020) (Unterhitzenberger et al. 2020)	Randomized Controlled Trial (RCT)	• This study analyzed 139 participants: children and adolescents who reported traumatic loss (n = 23; 14.5% of the total study sample), Sexual Abuse (SA) (n = 59; 37.1%), or Physical Violence (PV) (n = 55; 34.6%) as their trauma index.	12 sessions of TF-CBT, each of which was 90-100 minuted length	PTSS symptoms improved for SA and PV, ds = 0.76 and 0.98, respectively, but not for traumatic loss, d = 0.23
M. Hébert, & I.V. Daignault (2015) (Hébert and Daignault 2015)	Quasi experiment	• This study used a sample of 25 preschool children,	TF-CBT with approximately 8-16 sessions	TF-CBT has been proven to reduce children's behavior problems statistically

		including 15 girls and ten boys aged 3 to 6 years, with an average age of 5.26. Families were recruited at an initial evaluation of a special intervention setting in Montreal, Quebec, Canada.		significantly; internalization (p: 0.000), externalization (p: 0.000), posttraumatic stress symptoms (p: 0.000), and child avoidance behavior were not affected. Parental psychological problems such as psychological distress (p: 0.020) and posttraumatic stress symptoms (p: 0.000).
Paul O'Callaghan, John McMullen, Ciara´n Shannon, Harry Rafferty, Alastair Black (2013) (O'callaghan et al., 2013)	Randomized Controlled Trial (RCT)	• • The sample for this study was 52 war-affected girls aged 12 to 17 who experienced rape and inappropriate sexual touching in the Democratic Republic of the Congo.	TF-CBT with 15 sessions	The TF-CBT treatment group experienced a very significant reduction in trauma symptoms with a very large effect size (p 0.001), a very significant reduction in depression and anxiety with a very large effect size (p 0.001), a very significant reduction in behavior problems with a very large effect size (p 0.001). A large effect size (p 0.001) and a significant increase in prosocial behavior with a medium effect size (p 0.05).

DISCUSSION

Sexual violence is a condition that causes trauma to the victim. Experience as a victim of sexual violence has been proven to influence cognitive, behavioral, and social responses. Based on the results of the article review, it was found that the implementation of trauma-focused cognitive behavioral therapy (TF-CBT) had a positive influence on the condition of children who were victims of sexual violence. TF-CBT aims to reduce post-traumatic stress symptoms in victims and improve their skills in coping with trauma (Cohen and Mannarino, 2015).

Implementation of TF-CBT

Trauma-focused-cognitive behavioral therapy focuses on aspects of trauma and cognitive and behavioral changes. This review found differences in sessions used for TF-CBT. This difference is due to the need for repeated or separate sessions between parent and child. The therapist determines the number of sessions by considering the client's condition (Cohen, Mannarino, and Deblinger, 2017). The implementation of TF-CBT consists of 8-20 sessions (the majority use 12 sessions) involving caregivers whose status is not involved in cases of violence in the therapeutic process (Caouette et al., 2021; Cabrera et al., 2020 Newman et al., 2018; Hébert and Amédée 2020; Unterhitzenberger et al., 2020; O'callaghan et al., 2013). The duration of therapy is 45-100 minutes for each session, namely:

a) Building report cards and orientation about therapy and TF-CBT. An explanation of the implementation involving child-parent relationships, the goals, and the focus of therapy on efforts to overcome trauma are explained in this session. Openness during the therapy process needs to be emphasized in this orientation. Problems that may arise are concerns about confidentiality and discomfort when having to share the trauma with the family members involved. These problems can be overcome by exploring concerns, finding joint solutions, and making settlement agreements (Cohen and Mannarino, 2015).

b) Psychoeducation and reactions to trauma (involving parental support). Explanation of the trauma response in children as a normal process and connecting it with what the child experiences. Psychoeducation provides an understanding that children can recover from long-term trauma and return to carrying out their functions positively. Factors that trigger the return of trauma need to be emphasized at this stage. This stage can also teach caregivers to provide initial help to prevent the return of trauma and provide a good response when the child's trauma is triggered (Caouette et al., 2021; Cohen and Mannarino, 2015).

c) Relaxation. Relaxation techniques can be used. The choice of relaxation technique can be adjusted to the child's interests. Relaxation techniques can also be applied to caregivers.

d) Recognize the emotions felt

e) Assessment of feelings and modulation of momentary emotional expressions

f) Grounding and mindfulness

g) Cognitive processes. Therapists help children recognize the relationship between thoughts, feelings, and behavior (cognitive triangle) and replace maladaptive cognitions (unhelpful thoughts) related to everyday events with more helpful cognitions. This treatment was also carried out on the caregiver (Caouette et al., 2021; Cohen and Mannarino, 2015).

h) Creating a trauma narrative and processing traumatic experiences. Children are asked to write narratives related to the trauma they have experienced. Then, the narrative will be given to the parents, and a direct sharing session will be held between the children and parents. At this stage, parents can better understand what they have never heard (Caouette et al., 2021; Cohen and Mannarino, 2015).

i) Managing trauma with in vivo techniques. This technique teaches children not to avoid but rather to face conditions that trigger trauma. Children are gradually exposed to trauma-related fears that interfere with the child's basic needs. This stage involves the role of the caregiver in providing support, praise, patience, and commitment in accompanying the child to face conditions that trigger trauma. This technique should only be started with full commitment from the parents/caregivers

j) Joint sessions between children and parents to share traumatic experiences. This session begins with a therapist meeting with the child (5-10 minutes), a therapist meeting with the parents (5-10 minutes), and a joint meeting between the child, parents, and therapist (40-50 minutes). Children and parents are facilitated to ask questions, share what they feel, and discuss matters related to the incident that caused the trauma and the efforts that will be made together to achieve a state of recovery (Cohen and Mannarino, 2015).

k) Improve and develop safety in the future. Traumatic events will reduce children's sense of trust and security. This stage facilitates families and children in finding solutions, ensuring safety, and establishing commitment for the next moment (Cohen and Mannarino, 2015).

l) Review and termination (Caouette et al., 2021; Cohen and Mannarino, 2015).

TF-CBT facilitates victims of sexual violence to improve judgment, regulate pent-up emotions, and build good social support. This therapy has many sessions, so its implementation takes a long time. This review found that treatment lasted approximately 1-4 months. This can increase the risk of patients dropping out or stopping in the middle of the therapy process. Therefore, the initial session as an entry point is very important in the success of therapy. The report process between therapist and client is the main key. Each session can be done more than once, considering the output. Some studies use different time durations and number of meetings (Caouette et al., 2021; Cabrera et al., 2020; Hultmann et al., 2023; Newman et al., 2018; O'callaghan et al., 2013).

According to several articles analyzed, several things need to be considered during the TF-CBT intervention process, such as a safe environment that does not trigger trauma memories (Caouette et al., 2021; Cohen and Mannarino, 2015). TF-CBT, which involves the role of parents in the intervention, can provide good support in trauma recovery for children who are victims of sexual violence (Cohen and Mannarino, 2015). The symptoms affected by each group given TF-CBT were different. Therapy for preschool children will have challenges due to children's less mature cognitive abilities compared to school-age and teenagers. Therefore, the solution is to involve parents in the therapeutic process actively.

Cultural and environmental factors play an important role in the success of TF-CBT. Recommendations for modifications to the implementation of TF-CBT were also provided (Lee and Lang, 2023). Modifications made to TF-CBT therapy are the use of regional languages and traditions in the environment as the method chosen for emotional regulation sessions. This can improve the therapist's rapport with the client in the initial phase. When the report card has been achieved, the client will happily attend each therapy session until completion.

Benefits of TF-CBT for Victims of Sexual Violence

Trauma-focused cognitive behavioral therapy (TF-CBT) helps individuals be able to deal with trauma with the sessions it contains. Trauma-focused cognitive behavioral therapy (TF-CBT) uses its comprehensive approach to address the complex emotional and psychological issues that arise from traumatic experiences (Damayanti et al., 2022; Cowan and Ashai, 2020; Hanson and Wallis, 2018). TF-CBT not only focuses on changing cognitive aspects and deviant behavior but also pays attention to the negative feelings experienced by individuals who have experienced trauma. It can help with better trauma recovery and reduce recurrence rates (Brown et al., 2018). TF-CBT facilitates education about trauma and its impact on children. This can

help them understand that their experiences are not their fault and that they are not alone. This therapy teaches coping skills and relaxation techniques and increases Family Engagement. The involvement of caregivers in TF-CBT sessions can also reduce dropout rates, as the caregiver is more invested in the child's treatment and is more likely to ensure the child attends sessions (Caouette et al., 2021; Cohen and Mannarino, 2015). Research obtained from the ten articles reviewed shows the many benefits of TF-CBT.

TF-CBT has been proven to reduce symptoms of psychological problems in children and adolescents (Caouette et al., 2021; Cabrera et al., 2020; Cohen and Mannarino, 2015). TF-CBT successfully effected a preschool group with internalizing symptoms (sadness, loneliness, anxiety) and dissociative symptoms (short-term memory loss) (Caouette et al., 2021). These effects persisted six months after the end of the intervention (Caouette et al., 2021). TF-CBT is effective in reducing PTSD (Jensen et al., 2022; Hultmann et al., 2023), Depression (O'callaghan et al., 2013), Suicide attempts (Newman et al., 2018), psychology distress (Hébert and Amédée, 2020), and behavioral problems (Hébert and Amédée, 2020;O'callaghan et al., 2013).

Implementation of TF-CBT, which involves support from parents or family, has a positive impact on the trauma recovery process in children as victims of sexual violence (Cohen and Mannarino 2015). Parental involvement can also help parents change perspectives or replace maladaptive cognitions regarding things that happen to children, such as blaming themselves for what their child is experiencing. It can be changed by having joint child and parent sessions. Parents can replace maladaptive thoughts with information that the events their children experience are beyond their control.

4.   CONCLUSION

Systematic research shows that TF-CBT is a therapy that can help improve the condition of trauma victims. TF-CBT also influences the victim's behavioral and cognitive aspects by paying attention to the victim's trauma condition. The application of TF-CBT also has a positive impact on patients' depressive symptoms. The findings of this study indicate the need to implement therapy that focuses on trauma victims, especially victims of sexual violence— creating culturally sensitive TF-CBT so that it can be used more easily and have a better impact on victims. With its cultural diversity, Indonesia needs to pay attention to therapy with cultural considerations, such as relaxation techniques or regulations that use existing culture or customs. TF-CBT has been proven to provide benefits for victims of sexual violence and their families, such as reducing trauma symptoms. TF-CBT therapy can be disseminated more evenly in every health service by paying attention to the number of sessions each client can attend. Further research also needs to be carried out in Indonesia, considering that the conditions of Indonesian society differ from those of the communities studied previously..

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Papaya Juice Treatment Increases Body Weight and Decreases Urea Levels in Lead acetate-exposed Wistar Rats

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Abstract

Lead (Pb) exposure poses significant health risks due to its non-degradable nature and profound toxicity, causes oxidative stress and organ damage, particularly targeting the kidneys. Urea nitrogen levels rise as a result of decreased renal filtration rate and urea excretion. This study investigates the potential of papaya juice, rich in flavonoids, vitamins C, E, and beta-carotene, as a protective agent against Pb-induced nephrotoxicity. A Completely Randomized Design experiment was conducted, involving six treatment groups of Wistar rats. Papaya juice was administered at doses of 3.6, 7.2, and 14.4 g/200g body weight (BW) to Groups P1, P2, and P3, respectively, prior to exposure to 50 mg/kg BW of lead acetate. Group PC received vitamin E (400 IU/kg BW) and lead acetate, while Group NC was exposed to lead acetate alone. Group NT served as the control. Following a 28-day treatment period, the P3 group exhibited the most significant improvements, with a notable increase in body weight (22.50 grams) and a substantial decrease in urea nitrogen levels (18.24 mg/dl). These findings underscore the efficacy of papaya juice treatment in mitigating Pb-induced nephrotoxicity, suggesting a potential therapeutic regimen for alleviating lead toxicity in exposed populations. Eventually, the optimal dosing for papaya juice treatment, either at 14.4 g per 200 g body weight for rats or consumption of one medium-sized papaya for humans, yields compelling benefits. This regimen demonstrates significant efficacy in increasing body weight and lowering serum urea levels in rats subjected to Pb acetate exposure.

Keywords: Papaya Juice, Body Weight, Urea Levels, Lead Acetate.

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1. INTRODUCTION

Lead (Pb) is classified into two types: organic lead and inorganic lead. Organic lead pollution is caused by the use of leaded gasoline in the form of Tetra Ethyl Lead (TEL), which easily evaporates and dissolves in fats (Kamilatussaniah, Yuniastuti, & Iswari, 2015). The air pollution resulting from TEL emissions from motor vehicles in Indonesia will persist as long as the government permits the use of this substance in vehicles. will persist as long as the government permits the use of this substance in vehicles. This situation is deeply concerning because transportation emissions constitute the primary source of pollution in Indonesian urban areas, accounting for 85% of pollution, thereby rendering humans susceptible to exposure to hazardous substances. Inorganic lead pollution in the environment stems from industrial processes such as battery recycling, ceramic tableware manufacturing, paint production, and water pipe construction. Humans are exposed to organic and inorganic Pb particles in the environment through inhalation, oral ingestion, or skin adsorption. Lead that enters the body enters the bloodstream. Lead entering the body circulates in the bloodstream with a half-life of approximately 30 days before being distributed to various organs or soft tissues, including the liver, kidneys, brain, heart, lungs, spleen, and hard tissues such as teeth, bones, and hair, primarily as lead phosphate (Collin et al., 2022; Wulandari, 2020; Gusnita, 2012).

Lead is a non-degradable and highly toxic heavy metal (Rizal, 2022; Kumar et al., 2020). Accumulation of Pb2+ ions in biological systems causes oxidative damage and health problems such as central nervous system dysfunction, reproductive dysfunction, hematopoietic disorders, liver and kidney damage, cardiovascular issues, immune system dysfunction, and carcinogenic effects (Wulandari, 2020). A survey conducted by the Environmental Control Agency of West Java Province in May 2008 found that a significant portion of elementary school students in Bandung City in 2008 had blood lead levels exceeding the threshold of 10 ug/dl, leading to anemia (Wulandari, 2020). The presence of lead in the blood at levels of 30–60 g/dL in the renal system can result in severe kidney failure (Collin et al., 2022). The accumulation of Pb2+ ions in the body due to lead poisoning increases the levels of Reactive Oxygen Species (ROS) compounds such as hydroperoxides, hydrogen peroxide, and singlet oxygen. This occurs due to a decrease in antioxidant defenses in the body, leading to the induction of oxidative stress, cell damage, and impaired organ function, including the kidneys, accompanied by an elevation in Blood Urea Nitrogen (BUN) levels (Yuniarti et al., 2021; Kumar et al., 2020; Wani, Ara, & Usmani, 2015). Lead poisoning affects kidney disorder in 75% of Semarang car painting workers. This is due to the presence of Pb chromate molybdate and Pb sulfate compounds in car paint. These compounds can enter the body through the respiratory, digestive, and skin systems (Muliyadi, 2015).

Chronic lead poisoning causes fatigue, anxiety, decreased appetite, decreased concentration, and hypertension (Wulandari, 2020; Rosyidah, 2010). Research results indicate that lead toxicity can lead to weight loss in rats and hinder their growth. This is attributed to decreased appetite and disrupted nutrient absorption due to metabolic disturbances in the body (Ramah, Nabila, & El-shewey, 2015). Curative efforts for lead toxicity can rapidly reduce blood lead levels and excrete lead through urine, but may cause side effects such as Calcium Disodium Ethylenediamine Tetraacetic Acid (CaNa2EDTA) inducing encephalopathy, and the combination of Dimercaprol and CaNa2EDTA causing increased liver enzymes and nausea (Flora & Pachauri, 2010). Preventive measures are prioritized over curative actions.

Papaya contains phenolic compounds such as flavonoids that prevent lipid peroxidation. Besides its sweet taste, papaya fruit contains vitamins such as Ascorbic Acid (vitamin C), Tocopherol (vitamin E), and beta-carotene, which act as antioxidants by scavenging radicals caused by Pb exposure (Sari, & Santika, 2023; Suhartono, Nijka, Anhar, Sari, & Marisa, 2015).

This study aims to determine whether papaya juice treatment increases weight and decreases urea levels in Wistar rats exposed to lead acetate.

2. RESEARCH METHOD

This study employed a completely randomized design experimental approach (CRD). According to Federer's (2008) formula, the number of male white rats (*Rattus norvegicus*) Wistar strain used in this study was 24. There were six treatments, which were repeated four times:

Groups	Treatment	dose	Exposure
P1		3.6 g/200 g BW/day	
P2	papaya juice	7.2 g/200 g BW/day	Pb acetate at 50 mg/kg BW/day.
P3		14.4 g/200 g BW/day	
Positive Control (PC)	Vit. E (α-tocopherol)	400 IU/kg BW/day	
Negative control (NC)	-	-	
Non Treatment (NT)	-	-	-

The rats were administered the treatment for 28 days before blood samples were obtained on the 29th day. The detailed procedures are provided in the research stage section.

The research was conducted at the Laboratory of the Center for Food and Nutrition Studies at Gajah Mada University (UGM) Yogyakarta, which had applied for permission from the Health Ethics Committee at Surakarta State University and received a letter No: 1.117/XII/HREC/2017.

The test animals were male white rats (*Rattus norvegicus*) Wistar aged 13-14 weeks, weighing 180-250 g, and were healthy (actively moving, willing to eat, not physically disabled, who were fed standard pellet feed and aquadest drink given ad libitum). Rats were acclimatized for 7 days before and 28 days after treatment. The rats were kept in a laboratory environment with a temperature of (25°C) and 12 hours of light (light-dark) alternated.

The following materials were used in the study: California variety ripe papaya acquired straight from papaya producers in Rajek Wetan Tirtoadi Mlati Sleman, Lead Acetate Pb(CH3.CO2)2Pb.3H2O Merck Darmstadt, Germany, Vitamin E (Alpha-tocopherol) or NaturE® 100 IU, and Ureum diasys®. The tools used include a UV-visible spectrophotometer, cuvette, centrifuge, set of animal cages, micropipette, analytical balance, vortex mixer, centrifuge, blender, volume pipette, measuring pipette, oral syringe, microtube Eppendorf, glass beaker, test tube rack, incubator, and aluminum foil. The research stage includes:

1) Determination of Papaya Varieties The

The papaya plants were identified at Gadjah Mada University's Faculty of Biology, Plant Systematics Laboratory. According to the test results based on Certificate Number: 01226/S. Tb/I/2018, the papaya is *Carica papaya L.* var. Calina IPB - 9, also known as the California papaya.

2) Papaya Juice Making Papaya

Ripe fruit, or ready to harvest, aged ± 3 months, orange flesh, sweet and distinctive aroma of papaya. The ripe papaya is then peeled and blended without the addition of water to make juice. Every day, new papaya juice is prepared and stored in a clean container. Using a gastric probe, white rats (*Rattus norvegicus*) strains Wistar were given papaya juice orally twice a day.

3) Serum Making

Blood was drawn from the orbital vein area of the rat's eye. 3 mL of blood was drawn, collected in an Eppendorf tube without anticoagulant, and allowed to settle at room temperature

for 30 minutes. After that, the sample was centrifuged for 20 minutes at 3000 rpm. The clear part (serum) is separated and used to test serum urea levels.

4)   Serum Ureum Level Measurement

The serum urea level was measured spectrophotometrically using the enzymatic method. The enzyme urease hydrolyzes urea in the presence of water to produce ammonia and carbon dioxide, which is the basic principle of the experiment. Ammonium ions react with hypochlorite and salicylate to produce a green color. The color intensity is proportional to the concentration of urea in the sample. Methods, reagents, and quality control procedure utilizing Ureum diasys®. The working procedures are as follows:

a.   The sample solution, which contained 1 ml of reagent 1A and 0.01 ml of serum, was incubated for 5 minutes at 37°C before adding 1 ml of reagent 2 and incubated at 37°C for another 5 minutes.

b.   The blank solution containing 1 ml of reagent 1A and 0.01 ml of distilled water was then incubated for 5 minutes at 37°C, then 1 ml of reagent 2 was added, and incubated for 5 minutes at 37°C.

c.   The standard solution containing 1 ml of reagent 1A and 0.01 ml of standard solution reagent was incubated for 5 minutes at 37 °C, then 1 ml of reagent 2 was added and incubated for 5 minutes at 37°C.

d.   The blank, standard, and sample were measured using a UV-visible spectrophotometer at a wavelength of 578 nm. The standard reagent concentration is 50 mg/dl. Urea levels were calculated using the following formula:

$$\text{Urea (mg/dl)} = \frac{\Delta \text{ A Sample}}{\Delta \text{ A Standard}} \text{ X concentration standard (mg/dl)}$$

5)   Weight gain of Wistar Rats

The weighing of rats using an analytical balance was carried out four times every week for 28 days. The rats were also weighed before and after the acclimation process. The one-week acclimation period aimed to stabilize the metabolism of the rats with the conditions in the experimental environment. The weight gain was calculated as the weight of the Wistar rats in the fourth week minus their weight after acclimation. The weight gain data of the rats were then averaged per treatment group.

The data analysis used the Mann-Whitney test. This analysis was used to determine the difference between the two groups of each treatment. Changes in Body Weight of Wistar Rats used The One-Way ANOVA parametric test was used because the data were normally distributed, and the assumption of homogeneity was met. The aim was to determine the effect of giving papaya juice on changes in body weight of rats exposed to Pb acetate. Duncan's test was used to determine the most effective treatment or dose for weight gain.

3.   RESULTS AND DISCUSSION

a.   Urea levels in Wistar rats

Pb acetate toxicity causes dilation in the lumen of the renal tubules, inflammation, degeneration, damage, and necrosis of renal tubular epithelial cells, accompanied by increased tubular cell permeability and reduced membranes. The renal glomerulus causes the filtrate to cross the lower tubular membrane, back into the interstitium, and into the blood circulation, thereby increasing the retention of nitrogenous wastes in the serum, leading to increased urea levels (Sudjarwo et al., 2019). The previous research showed that there was an increase in blood urea levels in male Wistar rats exposed to lead. Kidney organs damaged by oxidative stress also reduce kidney function and GFR, resulting in increased levels of urea in the blood. Urea is the product of protein catabolism produced by the liver and excreted by the kidneys. If the

kidneys are damaged, urea cannot be excreted, leading to an increase in blood urea levels (Sudjarwo et al., 2019).

The results in Table 1 indicate that when rats were given different doses of papaya juice (P1, P2, P3), there was a notable impact on their urea levels. This impact was confirmed by the Kruskal-Wallis test, which showed a significant difference among the groups. The p-value obtained from the test was 0.001, which is less than the commonly used significance level of 0.05. This means that the effect of administering papaya juice at these doses on the urea levels of Wistar rats is statistically significant.

Table 1. A Levels of urea in mice given papaya juice and exposed to lead acetate.

Test Statistics	Urea levels
Chi-Square	21,820
df	5
Asymp. Sig.	.001

According to the Mann-Whitney test results in Table 2, the group of rats exposed to Pb acetate at a dose of 50 mg/kg BW/day (NC group) had much higher urea levels (52.06 mg/dl) compared to the group not exposed to Pb acetate (NT group), which had urea levels of 12.07 mg/dl. This increase in urea levels is because the kidneys are not excreting urea as effectively due to a decrease in the glomerular filtration rate (GFR), which happens because of oxidative stress Exposure to Pb^{2+} ions generates a lot of free radicals, which cause lipid peroxidation. This damages the glomerular membrane, leading to problems like renal tubular vacuolization and hydropic degeneration. In simpler terms, exposure to lead reduces the kidneys' ability to filter waste properly, causing urea levels to rise, and this is due to oxidative stress damaging the kidneys.

Exposure to Pb also inhibits the synthesis of the Superoxide dismutase (SOD) enzyme (Sudjarwo et al., 2019). Lead easily infiltrates the body, and interacts with carboxylic groups (-COOH) and amino (NH2) groups, also disrupting metabolic processes. The inhibition of SOD enzyme activity happens because lead ions can displace vital minerals like zinc, copper, and manganese, which are cofactors essential for SOD enzymes (Fukai & Ushio-Fukai, 2011; Sudjarwo et al., 2019).

Superoxide dismutase is an enzyme that helps fight oxidative stress caused by superoxide anion free radicals (O_2*). These free radicals can hinder SOD's activity. This hindrance occurs when there's a significant increase in the amount of superoxide anions due to exposure to Pb^{2+} ions, leading to a decrease in SOD activity in neutralizing O_2.

Papaya fruit contains several minerals such as calcium (Ca^{2+}), magnesium (Mg^{2+}), iron (Fe^{2+}), zinc (Zn^{2+}), potassium (K^+), copper (Cu^{2+}), manganese ($Mn^{2+)}$ and sodium ($Na)^+$ (Wall, 2006); Zhai, Narbad, & Chen, 2015; Kordas, 2017). The presence of these minerals can prevent mineral deficiencies, especially copper and manganese which act as cofactors for SOD enzymes (Purlinda & Simanjutak, 2020). Increased SOD enzyme activity can prevent oxidative stress in rats exposed to lead acetate, thus preventing kidney damage and decreased kidney function.

Moreover, a study has demonstrated that a higher dosage of papaya juice can prevent nephrotoxicity by enhancing SOD enzyme activity in the kidney tissue of rats exposed to lead acetate. The papaya juice treatment, especially in the P3 group, increased the antioxidant activity of superoxide dismutase (SOD) the most in the kidney tissue of Wistar rats. In the P3 group, SOD activity increased by 39.24 units per milliliter (u/ml) of kidney tissue compared to 36.46 u/ml in the P2 group and 31.73 u/ml in the P1 group (Purlinda & Simanjutak, 2020).

Additionally, table 2 has been shown serum urea levels decrease with increasing doses of papaya juice, and the effective dose of papaya juice is 14.4 g/200 g BW/day. The higher doses of papaya juice can reduce serum urea levels in rats exposed to lead acetate (Purlinda & Simanjutak, 2020). Furthermore, the flavonoid content of California papaya fruit is measured at 59 milligrams per 100 grams, surpassing that of Malaysian papaya (38.12 mg/100 g), Hong Kong papaya (36.26 mg/100 g), and breeding lines papaya (15.9 mg/100 g) (Iamjud, et al., 2016; Addai, et al., 2013).

Table 2. Average urea levels in rats.

Treatment with	Urea levels (mg/dl) (Mean ± SD)	Test Man Whitney	Asymp. sig (2-tailed) Value
P1	33.13 ±2.02 a	P1 and P2	0.019
		P1 and P3	0.020
		P1 and PC	0.020
		P1 and NC	0.020
		P1 and KS	0.019
P2	27.48 ± 1:29 b	P2 and P3	0.020
		P2 and PC	0.020
		P2 and NC	0.020
		P2 and NT	0.019
P3	18.24±3:08 c	P3 and PC	0.663
		P3 and NC	0.021
		P3and NT	0.020
PC	19.52 ± 1:28 c	PC and NC	0.021
		PC and NT	0.020
NC	52.06±1.96 d	NC and NT	0.020
NT	12.07±0.43 e	-	-

Phenolic compounds, such as flavonoids (quercetin), in papaya have the potential to prevent lipid peroxidation. They contain hydroxyl and carboxyl groups, which allow them to donate more hydrogen atoms to free radicals than certain vitamins, such as vitamin C (ascorbic acid), vitamin E (α-tocopherol), beta-carotene, and mineral content in papaya fruit. Furthermore, phenolic compounds can maintain the integrity of cell membranes by preventing the entry or diffusion of free radicals into cell membranes (Sasmita, 2017; Michalak, 2006; Suhartono, et al., 2015). The phenolic compounds are able to protect and fight against oxidative stress caused by lead exposure (Ramah et al., 2015)

The rats's urea levels in table 2 also did not show a significant difference in P3 and PC groups, as the p-value was $0.663 > 0.05$. This proves that papaya juice at a dose of 14.4 g/200 g BW/day has the same effectiveness as vitamin E at a dose of 400 IU/kg BW/day in preventing decreased kidney function due to Pb toxicity. Tocopherol (Vitamin E) could prevent cell membrane damage caused by ROS (Ramah et al., 2015). In a previous study, Mehdipour et al. also stated that dried Carica papaya juice was comparable to the antioxidant-tocopherol 10 mg/kg/day in lowering lipid peroxides and increasing total antioxidants in the blood of rats (Jang, et al., 2008).

b.   Weight Gain of Wistar Rats

Papaya juice contains antioxidants that can prevent oxidative stress. Papaya juice contains antioxidants, such as vitamins C, E, carotenoids, and flavonoids, that can prevent oxidative stress and free radical chain reactions. This, in turn, prevents lipid peroxidation

caused by lead exposure (Jang, et al., 2008; Usmayani et al., 2015; Iamjud et al., 2016; Wall, 2006; Suhartono, et al., 2015).

According to Table 3, the One-Way ANOVA test analysis revealed that the papaya juice treatment had a p-value of 0.000 (which is less than 0.05), indicating a significant difference in the mean weight gain among the rats in the six treatments. In simpler terms, this means that the variance in population weights was not consistent.

Subsequently, Duncan's test was employed to determine the effective dose of papaya juice on the weight gain of Wistar rats exposed to lead acetate. The results of this test indicated that the highest weight gain observed was 22.50 grams in the P3 group, compared to 12.75 grams in the P2 group and 6.50 grams in the P1 group. Based on these findings, it can be inferred that the higher the dose of papaya juice treatment, the more significant the increase in the rats' body weight. Therefore, the papaya juice treatment at a dosage of 14.4 grams per 200 grams of body weight was effective in enhancing the body weight of Wistar rats exposed to lead acetate at a dosage of 50 mg per kilogram of body weight per day.

Table 3. Weight Gain of Rats given Papaya Juice and exposed to Pb Acetate.

Treatment	Weight Gain (g) (Mean ± SD)
P1	6.50 ± 2.38 a
P2	12.75 ± 2.63 b
P3	22,50 ± 1.73 c
PC	20.50 ± 1.73 c
NC	-13.00 ± 2.16 d
KS	33.25 ± 2.63 e

Note: columns followed by the same letter are not significantly different at the p<0.05 significance level

In rats exposed to lead acetate at a dosage of 50 mg/kg BW/day, there was no significant difference in the mean weight gain of the rats in P3 and PC group (Sadeque et al., 2012). Similar to the results of this study, previous research has shown that both the aqueous extract of Carica papaya and tocopherol have the same ability to prevent hepatotoxicity, necrosis, and fat degeneration in rats induced by Carbon Tetrachloride (CCl_4). Likewise, metabolic disorders such as impaired absorption of nutrients can be prevented by giving vitamin E and papaya juice to rats exposed to Pb acetate, which prevents weight loss in the mice. The results showed that the weight gain in the Healthy Control treatment was 33.25 g, which tended to be higher than that of P3 at 22.5 g. This may be because the period of giving papaya juice was not long enough to observe the effect of increasing body weight in rats exposed to Pb acetate.

The content of vitamin C in papaya is 82.7 mg/100g, which is higher than in other tropical fruits such as mango (26.9 mg/100g), pineapple (7.2 mg/100g), banana (67.0 mg/100g) and oranges (8.0 mg/100g) (Iamjud et al., 2016). Vitamin C supplementation at a dose of 500 mg/day can increase body weight, prevent anemia, and increase the antioxidant activity of SOD in the blood, thereby preventing liver and kidney function disorders (Sancho, Yahia, & González-aguilar, 2011; Eshginia & Marjani, 2013; Ghanwat, 2016). The mechanism of action of vitamin C is to donate H atoms to free radicals such as superoxide and hydroxyl radicals, and to synergize with -tocopherol. Vitamin C can also regenerate -tocopheroxyl radicals, increase iron absorption to compete with Pb in the intestine and prevent anemia. Additionally, it can increase Pb excretion through urine and feces (El-Neweshy & El-Sayed, 2011).

4. CONCLUSION

Optimal dosing for papaya juice, either at 14.4 g per 200 g body weight or consumption of one medium-sized papaya for humans, yields compelling benefits. This regimen

demonstrates significant efficacy in increasing body weight and lowering serum urea levels in rats subjected to Pb acetate exposure. Moreover, papaya juice stands out as a natural antioxidant, effectively counteracting the deleterious effects of free radicals induced by lead acetate. Thus, both the specified dosage and the consumption of whole papaya offer promising avenues for mitigating lead toxicity and promoting overall health

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R E S E A R C H   **Open Access**

The Flavonoids, Phenolics, and Antioxidant Activity from Ethanol Extract of *Fibraurea tinctoria* Lour

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Abstract
Oxidative stress has long been associated with increased risk for several diseases. Antioxidant is a molecule that inhibits the oxidation of other molecules and delays or prevents oxidative damage. Natural phenolic and flavonoid compounds are plant secondary metabolites directly contributing to antioxidant activity. Fibraurea tinctoria Lour, often called the yellow root, is a plant that has long been known in the traditional medicine of the native tribes of West Kalimantan to treat several diseases, including malaria, jaundice, and diabetes. This study aimed to quantify the total phenolic (TPC) and flavonoid (TFC) contents and antioxidant activity of the ethanol extract of yellow root stems. Yellow root stems were extracted by maceration in 96% ethanol for four days. The total phenolic, flavonoid, and antioxidant activities were measured using the Folin-Ciocalteu, AlCl3, and DPPH methods. Phytochemical screening showed that the ethanol extract of yellow root stems contains phenolics, flavonoids, alkaloids, saponins, tannins, and steroids/triterpenoids. The total phenol and flavonoid contents were 40.2 mg GAE/g extract and 61.2 mg QE/g extract, respectively. The ethanol extract of yellow root stems showed moderate DPPH scavenging activity, with an IC50 of 152.13 ppm. From this study, it can be concluded that this plant could be a potential source of natural antioxidants.

Keywords: Fibraurea tinctoria Lour, Phenolics, Flavonoids, Antioxidant, DPPH.

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1. INTRODUCTION

Free radicals are physiologically active biomolecules generated during metabolic pathways and immune cells. The body requires a certain amount of free radicals to regulate the physiological activity of the cells. However, when the number of free radicals exceeds the physiological range, it causes oxidative stress (Sies, 2020). Oxidative stress interferes with normal cellular processes and causes cell damage, leading to numerous degenerative diseases, including cancer, diabetes, cardiovascular diseases, and neurodegenerative diseases. The body reacts to stress as a defense mechanism to maintain cellular homeostasis. Several endogenous antioxidant enzymes, such as superoxide dismutase, catalase, and glutathione peroxidase, can deactivate free radicals and preserve normal cellular activities. However, antioxidant enzymes are occasionally insufficient to combat free radicals and to sustain optimal cellular activities under elevated oxidative stress. Therefore, exogenous antioxidants are necessary (Sadeer et al., 2020).

Natural plant antioxidants and their derivatives have drawn particular attention because of their capacity to scavenge free radicals, exhibit better performance, and are less toxic than synthetic antioxidants. Medicinal plants with high levels of antioxidant constituents have been proposed as a practical therapeutic approach to many diseases. Among the phytoconstituents, phenolics, and flavonoids have attracted considerable interest and have been proven to be effective in counteracting oxidative stress because of their ability to directly contribute to antioxidant action through their hydroxyl groups by donating an electron or a hydrogen atom (Phuyal et al., 2020). In addition, these compounds also promote the synthesis of endogenous antioxidant molecules in cells. Numerous studies have shown that phenolic and flavonoid compounds exhibit free radical inhibition, peroxide decomposition, metal inactivation, or oxygen scavenging in biological systems to prevent the burden of oxidative diseases (Aryal et al., 2019).

One of the medicinal plants that have been widely used in the traditional medicine of the native tribes of Kalimantan was *Fibraurea tinctoria* Lour, or yellow root. The traditional uses of this plant are in the roots and stems. This plant is used by tribes in Kalimantan to treat diabetes, malaria, and jaundice (Noorcahyati et al., 2016). Several studies have been conducted regarding the pharmacological activity of *Fibraurea tinctoria* and have shown that this plant has anti-inflammatory, anti-malarial, anti-microbial, vasodilation, and anti-proliferative in cervical, oral, and liver cancer (Purwaningsih, Maksum, et al., 2023).

Since it was discovered that oxidative stress has been shown to participate in developing various chronic and degenerative diseases, the attention to plants as an essential source of exogenous antioxidants has increased. In addition, the use of natural antioxidants is also increasing, owing to studies indicating possible adverse effects that may be related to the consumption of synthetic antioxidants (Jomova et al., 2023; Martemucci et al., 2022). This study aimed to measure the phenolic and flavonoid content in the ethanol extract of yellow root stems and evaluate the antioxidant activity using the DPPH method. Most phenolic chemicals, including flavonoids and anthocyanins, are responsible for the high antioxidant activity in plants. According to studies, the antioxidant capacity and the levels of phenolic and flavonoid compounds are strongly correlated. The antioxidant activity increases with the concentration of these substances (Muflihah et al., 2021). These findings suggest the importance of assessing the phenolic and flavonoid contents in yellow root stems to find promising natural antioxidants for future use in diverse fields such as medicine, food, and cosmetics.

2. RESEARCH METHOD

a. Plant material

The plants used in this study were collected from Menua Sadap Village in Kapuas Hulu District, West Kalimantan, and identified at the Biology Laboratory, Tanjungpura University, Pontianak, Indonesia.

b. Preparation of ethanol extract from yellow root stems

The stems of the yellow root were washed and dried for two weeks in an aerated manner, crushed using a wood hammer mill, and sifted with a particle size of 40 mesh. The powdered stem (1.00 kg) was extracted by maceration for four days using 96% ethanol, which was replaced daily. The filtrate was evaporated at 50°C until a thick extract was obtained (26.3 g).

c. Phytochemical screening evaluation

Phytochemical screening is used to determine the chemical compounds present in plant extracts. The identification of phytochemical compounds from ethanol extract of yellow root stems, including phenolics, flavonoids, alkaloids, saponins, tannins, and steroids/terpenoids (Farnsworth, 1966; Shaikh & Patil, 2020).

d. Determination of total phenolic contents (TPC)

The total phenolic content was calculated using the Folin-Ciocalteu method. The reaction mixture comprised 50 μL of supernatant and 2.5 mL of 10% Folin–Ciocalteu reagent. After 3 min, 2.0 mL of 7.5% Na_2CO_3 was added, then incubated at 45°C for 15 minutes. Absorbance was measured at 725 nm. Gallic acid was used as a calibration curve. Standard gallic acid in methanol was prepared in concentration of 30, 50, 100, 200, 300, 500, 750 and 1000 μg/mL. The mean of the two measurements was computed and represented as milligrams of gallic acid equivalents (mg GAE/g extract) (Pauliuc et al., 2020).

e. Determination of total flavonoid contents (TFC)

The $AlCl_3$ method was used to determine the total flavonoid content spectrophotometrically. One gram of samples was weighed, put in a volumetric flask measuring 25 mL, calibrated with ethanol, and then homogenized. Two milliliters of the samples were combined with 2 mL of 2% aluminium chloride ($AlCl_3$) ethanol, and absorbance values at 415 nm were recorded after 30 minutes of incubation. A standard curve of quercetin was used to calculate the total flavonoid content. Standard quercetin in ethanol was prepared in concentrations of 5, 10, 15, 20, and 25 μg/mL. The average of three measurements was determined and represented as milligrams of quercetin equivalents per gram of extract (mg QE/g extract) (Moo-Huchin et al., 2015).

f. Antioxidant activity evaluation

Free radical scavenging activity was determined using the DPPH (2,2-diphenyl-1-picrylhidrazyl) method. Five different concentrations of the sample solution in methanol (20, 41, 61, 81, and 102 μg/mL) were added to two milliliters of 0.1 mM DPPH solution. The mixture was vigorously mixed and incubated at room temperature for 30 minutes. The absorbance of the resulting solution was measured at a wavelength of 517 nm. The blank solution was the DPPH solution in methanol. The amount of antioxidants required to reduce the initial DPPH absorbance by 50% was used to express the radical scavenging activity and was expressed in ppm. Plotting the percentage disappearance of DPPH as a function of sample concentration allowed us to establish the IC_{50} value for each sample graphically. The following equation estimated the percent inhibition (Purwaningsih et al., 2020).

$$\% \ Inhibition = \frac{(A0 - A1)}{A0} \ x100\%$$

Where A_0 = absorbance of the control and A_1 = absorbance of the sample.

3. RESULTS AND DISCUSSION
a. Plant determination

The yellow root plants used in this study were obtained from Menua Sadap Village, Kapuas Hulu District, West Kalimantan. The determination was performed at the Biology Laboratory, Tanjungpura University, Pontianak. The determination results showed that the plants used in this study were *Fibraurea tinctoria* Lour from the *Menispermaceae* family.

b. Sample extraction

The extraction revealed an extraction yield was 2.63%. Many variables, such as the type and concentration of solvent, size of the simplicia particles, and extraction period, influence the yield result (Susanty & Bachmid, 2016). A maceration extraction method was employed in this investigation. The foundation of this technique is solid-liquid separation, with water or organic solvents acting as the liquid phase. Methanol, ethanol, water, or a mixture of these solvents is generally used to extract phenolic compounds. Maceration attempts to reduce compound loss or damage during extraction. This method can be used to analyze chemicals that are susceptible to heat. Particle size also significantly affects the extraction outcomes of maceration (Purwaningsih, Fathiah, et al., 2023).

c. Phytochemical screening

Phytochemical screening of the ethanol extract of yellow root stems revealed the presence of alkaloids, flavonoids, phenolics, saponins, tannins, and steroids/triterpenoids (Table 1).

Table 1. The phytochemical screening.

Secondary metabolites	Findings
Alkaloids	+
Flavonoids	+
Phenolics	+
Saponins	+
Tannins	+
Steroids/Triterpenoids	+/+

d. The total phenolic contents (TPC)

The gallic acid standard curve regression equation was y = 0.0011x + 0.0134 with R^2 = 0.997. The total phenolic contents of the ethanol extract of the yellow root stems were 40.2 mg GAE/g extract.

Table 2. The total phenolic contents.

Replication	Abs	Total phenolic contents		Average
		%	mg GAE/g	
1	0.486	3.97	39.7	40.2
2	0.496	4.06	40.6	

The total phenolic contents were determined colorimetrically using the Folin-Ciocalteu reagent based on the reducing power of the phenolic hydroxy groups. The Folin-Ciocalteu

reagent contains sodium molybdate and tungstate. This reagent can react with all types of phenol to form blue molybdenum, whose absorbance can be measured. The stronger the blue color, the higher the phenol content. The absorbance was read at 765 nm (Blainski et al., 2013; Lamuela-Raventós, 2018). Gallic acid, a derivative of hydroxybenzoic acid with a strong antioxidant effect, was used as a standard (Hudz et al., 2019).

e.   The total flavonoid contents (TFC)

The quercetin standard curve regression equation was $y = 0.0296x - 0.0088$ with $R^2 = 0.999$. The total flavonoid contents of the ethanol extract of the yellow root stems were 61.2 mg QE/g extract.

Table 3. The total flavonoid contents.

| Replication | Abs | Total phenolic contents | | Average |
		%	mg QE/g	
1	0.509	6.20	62.0	
2	0.503	6.13	61.3	61.2
3	0.494	6.02	60.2	

The principle of the $AlCl_3$ method was the ortho-hydroxyl group on rings A or B of the flavonoid compounds and $AlCl_3$ interact to form a stable complex. When $AlCl_3$ was added, the wavelength shifted toward the visible range, indicated by the appearance of a yellow tint. Sodium acetate is intended to maintain the wavelength in the visible region and provide an acidic environment because quercetin is stable in an acidic environment. Quercetin is a standard solution because it can react with $AlCl_3$ to form complexes (Shraim et al., 2021; Tristantini & Amalia, 2019).

f.   Antioxidant activity

The antioxidant activity of ethanol extract of yellow root stems was determined using the DPPH method and expressed as the IC_{50} value. This method is simple, inexpensive, rapid, and effective for thermally unstable chemicals because radical scavenging is measured at room temperature. Some studies also reported that this method has a good correlation for bioactive compounds (phenolics and flavonoids) with a regression factor $R > 0.8$ (Sadeer et al., 2020).

DPPH is a stable radical that appears purple and absorbs at λmax 515-517 nm. The principle of this method is that upon the reaction of the antioxidant with DPPH, the DPPH accepts the hydrogen donor, resulting in the reduction of DPPH to DPPH2, and the solution loses its color from purple to pale yellow. The color change is monitored spectrophotometrically and utilized to determine parameters for antioxidant properties (Angeli et al., 2023).
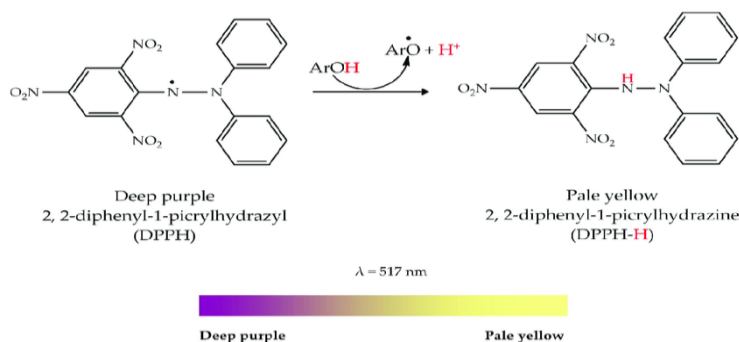
Figure 1. DPPH reaction mechanism (Sadeer et al., 2020)

From the correlation curve between the concentration against % inhibition of the ethanol extract of yellow root stems, the regression equation obtained, $y = 0.3259x + 0.42$ with $R^2 = 0.9954$. The calculation results of % inhibition and IC_{50} are presented in Table 4 and the graph of concentration against % inhibition of the ethanol extract of yellow root stems is shown in Figure 2.

Table 4. The antioxidant activity of ethanol extract of yellow root stems.

Concentration (ppm)	Abs	% Inhibition	Average % Inhibition	IC_{50} (ppm)
0	0,853	0,00	0,000	
0	0,853	0,00		
20	0,814	4,57	6,445	
20	0,782	8,32		
41	0,735	13,83	14,710	
41	0,720	15,59		152,13
61	0,671	21,34	20,520	
61	0,685	19,70		
81	0,621	27,20	27,670	
81	0,613	28,14		
102	0,577	32,36	32,415	
102	0,576	32,47		
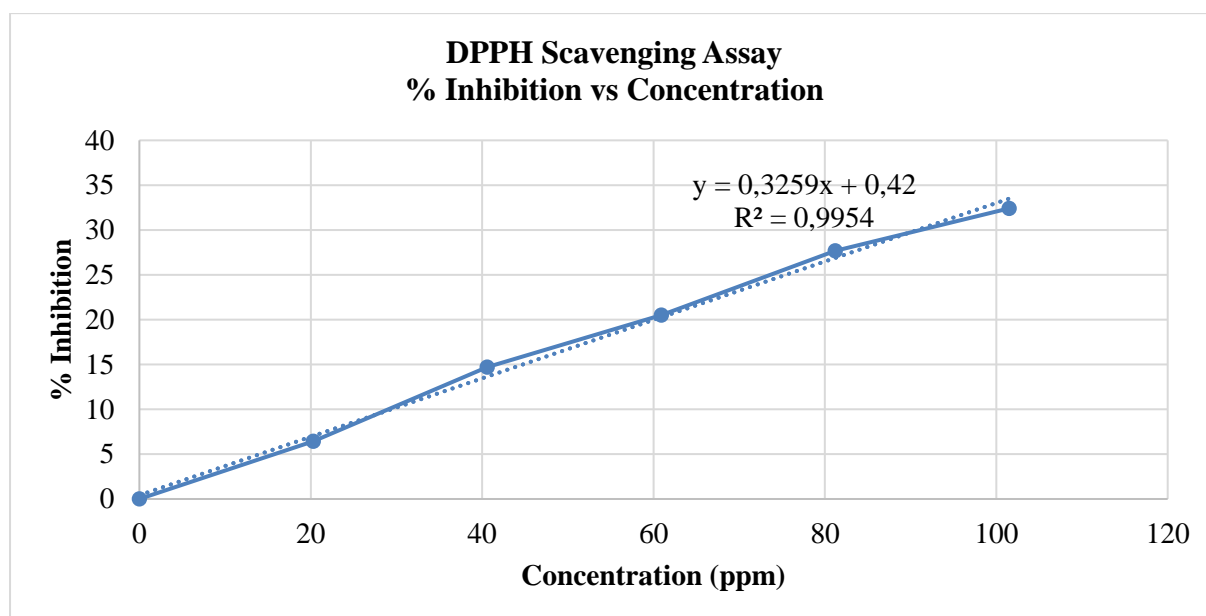
Figure 2. The graph of % inhibition against concentration.

The ethanol extract of yellow root stems showed moderate DPPH scavenging activity, with an IC_{50} value between 101-250 ppm, namely 152.13 ppm. A study of antioxidant activity of *Arcangelisia flava*, *Coscinium blumeanum*, and *Fibraurea tinctoria* from Thailand was published by Keawpradub et al. In their study showed that the stems of *Fibraurea tinctoria* extracted using petroleum ether and boiling water had $IC_{50} > 100$ µg/mL, whereas chloroform and methanol extract showed an IC_{50} 78.8 and 83.6 µg/mL, respectively (Keawpradub et al., 2005). Based on this study, our results showed a lower antioxidant activity than the chloroform

and methanol extract, but had the same activity as the petroleum ether and boiling water extracts of *Fibraurea tinctoria* from Thailand.

Phenolic compounds and flavonoids are important antioxidants for free radical inactivation because of their ability to donate hydrogen atoms to free radicals. They also have structural characteristics ideal for counteracting free radicals. Several kinds of literature showed that total phenolic and flavonoid content is linearly related to antioxidant capacity (Aryal et al., 2019). The redox properties of phenolic compounds enable them to function as antioxidants. Phenolic compounds reduce or inhibit free radicals by donating hydrogen atoms from their hydroxyl groups. Consequently, DPPH radicals are reduced to a more stable form (Santos-Sánchez et al., 2019). In addition, phenolic compounds can chelate metals, especially iron and copper, to inhibit the formation of metal-catalyzed free radicals (Vuolo et al., 2018). The number and position of the hydroxyl groups are known to influence the activity of phenolic compounds against free radicals. The greater the number of hydroxyl groups in the molecule, the greater the antioxidant activity (Prasonto et al., 2017).

Flavonoids are the most abundant phenolic compounds in various medicinal plants and the third-most bioactive plant compound, which has been reported to have about 10,000 in the literature (Khan et al., 2021). Several studies on antioxidant properties and their relationship to flavonoids have indicated that flavonoids can be used as potential drugs to prevent oxidative stress (Panche et al., 2016). The mechanism of the antioxidant activity of flavonoids, including free radical scavenging and the capacity to chelate metal ions, is influenced by the configuration, substitution, and number of hydroxyl groups in the molecule. The configuration of the B-ring hydroxyl group is the most important determinant because it donates hydrogen and electrons to the hydroxyl, peroxyl, and peroxynitrite radicals and then stabilizes them to produce a relatively stable flavonoid radical (Kumar & Pandey, 2013).

Several studies using natural flavonoids have investigated the relationship between the structure of flavonoids and their antioxidant activities. Typical chemical structures related to the antioxidant activity of flavonoids have been determined, including a hydroxyl group (C in Figure 6), an ortho-dihydroxy in ring B (A in Figure 6), and a C_2-C_3 unsaturated bond combined with a C_4 carbonyl group in the ring C (B in Figure 6), and O-methylation (Banjarnahor & Artanti, 2014).
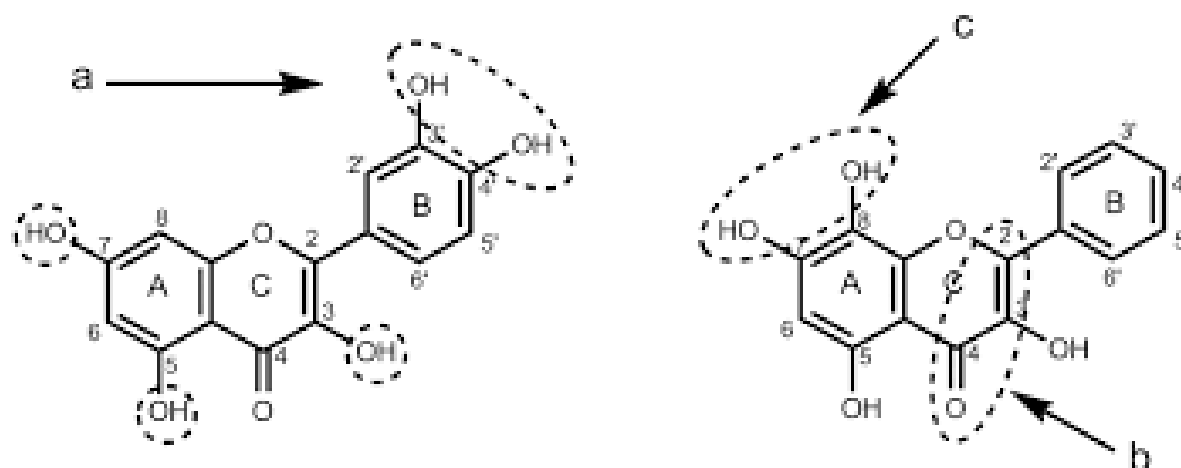

Figure 3. Antioxidant structure-activity relationships (Banjarnahor & Artanti, 2014).

Chelation of trace elements is another mechanism by which flavonoids exert their antioxidant effects. Because flavonoids have chelating capabilities, they can bind metal ions in

the body and stop them from oxidizing. Many flavonoids can chelate metal ions, including Fe^{2+} and Cu^+, which are crucial for oxygen metabolism and the production of free radicals (Banjarnahor & Artanti, 2014). The antioxidant activity of flavonoids can also be carried out indirectly, where flavonoids can act as intracellular antioxidants by inhibiting free radical-producing enzymes, such as NADPH oxidase (NOX), lipoxygenase (LO), cyclooxygenase (CO), and xanthine oxidase (XO) (Hernández-Rodríguez et al., 2018).

Considering the many mechanisms of antioxidant action and the limits of each test, research has indicated the necessity of performing multiple types of antioxidant activity measurements. Moreover, _in vitro_ antioxidant assays are based on _in vitro_ chemical reactions, which are different from actual physiological systems. However, the outcomes of _in vitro_ tests for antioxidant activity retain their usefulness in directing investigations involving humans. To ascertain the mechanisms underlying the antioxidant activity of this herbal extract, further research is required to separate and identify the specific phenolic or flavonoid compounds found in these samples.

4. CONCLUSION

The results of the present study suggest that this plant could be a potent source of natural antioxidants because of its phenolic and flavonoid content and its remarkable scavenging effects on DPPH. Although the parameters used in this study were not disease-specific, the quantification of antioxidant properties can serve as a guide for the use of these plants for ROS-related diseases. Further investigations are needed to isolate and identify the phenolic or flavonoid components responsible for the antioxidant activity of these plants, as well as their mechanisms of action, to authenticate their potential use as sources of natural antioxidants, and to validate their traditional uses in several medicinal practices.

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R E S E A R C H   **Open Access**

Mercury Pollution from Ilegal Gold Mining Activities and Its Impact on Human Health in the Anahoni River, Kaiely Bay, Maluku: A Review

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Abstract
Illegal gold mining in the Anahoni River area, Kaiely Bay, Maluku, intensifies mercury pollution, posing grave environmental and health risks. Statistical analyses reveal a significant correlation between illegal mining and escalating mercury levels, necessitating urgent intervention. Environmental impacts include biomagnification in fish, affecting indigenous communities dependent on these resources. Health risks encompass neurological, reproductive, and respiratory implications, warranting targeted public health interventions. Examining the broader context, the global dimension of mercury pollution underscores the interconnected nature of the issue, requiring collaborative efforts. The toxicological aspects of mercury and its biogeochemical cycling inform potential mitigation strategies. Methodologically, systematic literature reviews, field investigations, and socio-economic assessments provide a holistic understanding of mercury contamination. Results highlight alarming mercury concentrations, with significant correlations between mercury levels, deforestation, and fish abundance, emphasizing the need for evidence-based policy decisions. Human health implications are evident through a positive correlation between mercury concentrations in river water and human hair samples, emphasizing the direct link between environmental exposure and health risks. Environmental impacts extend beyond human health, affecting ecosystems and necessitating global collaboration. The study underscores the importance of comprehensive policy frameworks, international collaborations, and community engagement in addressing the socio-economic roots of illegal gold mining. Mitigation strategies encompass regulations, sustainable practices, alternative technologies, and community-based initiatives. This review contributes to a nuanced understanding of mercury pollution in the Anahoni River, providing insights into the interconnected challenges and opportunities for sustainable solutions within a concise framework.

Keywords: Anahoni River, Mercury Pollution, Environmental Consequence.

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1.   INTRODUCTION

The global scale is now facing a critical environmental and public health issue due to the increase in mercury pollution caused by illegal gold mining activities. This review focuses specifically on the Anahoni River, a vital waterway within the gold-rich Kaiely Bay region in Maluku, Indonesia, Illegal gold mining activities have resulted in a notable discharge of mercury into the water system. The repercussions of this pollution extend beyond environmental consequences, posing a formidable threat to the health and well-being of nearby communities.

Extensive reviews by Gibb & O'Leary, (2014) and Eisler, (2004) emphasize the severe health impacts associated In communities engaged in artisanal and small-scale gold mining, the issue of mercury exposure is a significant concern. Kaiely Bay has gained notoriety for its abundant gold deposits, attracting illegal gold mining characterized by rudimentary extraction methods that lack essential safeguards against mercury release (Kim et al., 2012; Manullang et al., 2020). The Anahoni River, flowing through this gold-rich region, has experienced a surge in mercury contamination due to these unregulated practices. Studies conducted by Manullang et al., 2020) the disclosure of high levels of mercury in the waters of Kaiely Bay highlights the significant and troubling effects of illegal gold mining on the nearby aquatic ecosystem.

The alarming level of mercury pollution within the Anahoni River ecosystem raises serious concerns, as indicated by studies such as those conducted by Mason & Sheu, (2002) on global mercury cycling. The Anahoni River, a tributary to Kaiely Bay, has witnessed a substantial increase in mercury levels due to the illicit gold mining practices in the region (Male & Sahuburua, 2021; Manullang et al., 2020). As mercury pollution is intertwined with broader environmental issues, such as changes in energy consumption patterns (Streets et al., 2009) and co-contamination of aquifers (Rakib et al., 2020). Conducting a thorough examination is crucial to gaining a nuanced comprehension of the difficulties and possibilities associated with addressing aquatic mercury pollution in modified environments (Hsu-Kim et al., 2018).

Moreover, the global dimension of mercury pollution, as outlined by Budnik & Casteleyn, 2019; Driscoll et al., (2013), emphasizes the urgency of addressing local instances of contamination. The interconnectedness of global mercury cycles underscores the importance of comprehensive assessments and Local-level interventions are being implemented to address the adverse effects of illegal gold mining activities.

When examining ecosystems similar to one another worldwide, the problem of mercury pollution is consistently observed in areas distinguished by artisanal gold mining. To illustrate, the consequences of deforestation on mercury contamination in the Amazon region are noteworthy, as highlighted by Roulet et al., (1999) and Roulet et al., (2000), provides insights into the intricate relationship between land-use changes and environmental consequences. Additionally, the gold mining regions of Lebong Regency in Bengkulu Province, Indonesia, as highlighted by Ali et al., (2018), face potential mercury toxicity, mirroring the challenges encountered in Kaiely Bay. The toxicological aspects of mercury, explored by Clarkson & Magos, (2006), form a critical component of the review, providing insights into the mechanisms through which mercury induces adverse health effects. Understanding the global biogeochemical cycling of mercury is crucial for developing successful mitigation and remediation plans. This knowledge provides a basis for comprehending the complex routes through which mercury moves within the environment, contributing to its persistence and ubiquity (Selin, 2009). This analysis combines a range of viewpoints to present a detailed comprehension of the mercury contamination resulting from illicit gold mining operations and its impact on human well-being in the Anahoni River, Kaiely Bay, Maluku.

To underscore the importance of community involvement, this study proposes strategies and initiatives for engaging local communities and relevant stakeholders in the research

process. The challenges are multifaceted, requiring a nuanced analysis of the socio-economic factors intertwined with the environmental predicament. As documented by (Castilhos et al., 2015; Driscoll et al., 2013), the complex interplay of socioeconomic factors influences the handling of mercury pollution in diverse ecosystems, necessitating tailored strategies. Lessons from studies such as those by Hsu-Kim et al., (2018) and Selin, (2009), underscore the significance of collaborative efforts and community participation in managing mercury pollution.

The objective of this study is to provide a thorough examination of the scope of mercury contamination caused by unauthorized gold mining operations, focusing specifically on the Anahoni River, Kaiely Bay, located in Maluku, Indonesia. By synthesizing findings from various scientific investigations and environmental assessments, we seek to provide a nuanced understanding of the ongoing challenges, potential mitigation strategies, and the imperative for stringent regulatory measures. Additionally, we will delve into the complexities of socio-economic factors, analyzing how addressing these aspects can contribute to sustainable solutions while acknowledging and overcoming the obstacles inherent in such endeavors. The inclusion of strategies for community involvement and an exploration of potential challenges aims to underscore the importance of collaborative and community-centered approaches in addressing mercury pollution in this ecologically sensitive region.

2. RESEARCH METHOD

This research adopts a comprehensive methodology to explore mercury contamination originating from illegal gold mining activities in the Anahoni River, Kaiely Bay, Buru Regency, Maluku. This approach integrates a systematic literature review, and empirical data collection through field investigations, laboratory analyses, and socio-economic assessments. The study employs a holistic methodology to investigate mercury pollution stemming from illegal gold mining in the Anahoni River, Kaiely Bay, Buru Regency, Maluku. This approach integrates a systematic literature review from relevant scientific journals and empirical data collection through field investigations, laboratory analyses, and socio-economic assessments.

Systematic Literature Review

To systematically review the existing scientific literature, a comprehensive search strategy will be employed, covering electronic databases such as PubMed, ScienceDirect, and Google Scholar. Keywords related to mercury contamination, illegal gold mining, and the Anahoni River ecosystem will be combined using Boolean operators. Additionally, a manual search will be conducted through relevant journals and the references of identified articles to ensure a thorough review. Information retrieval will involve exploring recent research on the effects of mercury on both river ecosystems and the well-being of humans, considering the methodology used and relevant findings (Malm, 1998; Mason & Sheu, 2002). Detailed examinations of the worldwide status of mercury pollution resulting from unauthorized gold mining activities will be taken into account, focusing on its effects on aquatic ecosystems and human health risks, the impact of mercury on freshwater ecosystems (Male & Sahuburua, 2021; Roulet et al., 1999), and its effects on aquatic ecosystems, and associated health risks for humans and (Selin, 2009; Streets et al., 2009).

Field Investigations

Field studies will be based on the literature used. The selection of sampling locations will involve a comprehensive field survey along the Anahoni River to identify potential mercury-contaminated points. The determination of sampling locations will consider geographical variations and the potential for high mercury concentrations. This process aligns with previous

findings recording increased mercury pollution after illegal gold mining activities (Legg et al., 2015). Sampling points along the Anahoni River will be strategically chosen to reflect various stages of the river's flow and potential mercury contamination points. Water samples will be collected to analyze mercury concentrations, following established sample preservation and transportation protocols (Eisler, 2004). Sediment samples will be obtained to assess the extent of mercury accumulation in riverbed deposits. Biotic components, particularly fish species, will be sampled to investigate mercury bioaccumulation and assess potential risks to the local food web (Mason & Sheu, 2002).

Laboratory Analyses

Advanced analytical techniques, including atomic absorption spectroscopy (AAS), will be employed to evaluate the concentration of mercury in both water and sediment samples (Li et al., 2009; Mason & Sheu, 2002). Biomarker analysis will be utilized to assess the levels of mercury in fish, offering valuable information on the bioavailability and biomagnification processes within the aquatic ecosystem (C. Y. Chen et al., 2018; Clarkson & Magos, 2006; Eisler, 2004).

Socio-Economic Assessments

Surveys and interviews will be conducted in local communities along the Anahoni River to understand socio-economic dynamics and awareness levels regarding mercury pollution. Data will include demographic details, means of earning a living, dietary patterns, and awareness of health risks related to mercury exposure (Hsu-Kim et al., 2018; Legg et al., 2015; Male & Sahuburua, 2021).

Data Analysis

Descriptive statistical analysis will be applied to quantify and interpret mercury concentrations in water, sediment, and biotic components. Correlation analyses will be conducted to explore potential relationships between mercury levels and various environmental factors (C. Y. Chen et al., 2018; Clarkson & Magos, 2006), understanding patterns of diet, livelihoods, and community awareness of health risks related to mercury (UNEP, 2013).

Integration of Findings

Findings from the literature review and empirical data collection will be combined to provide a comprehensive understanding of mercury contamination in the Anahoni River ecosystem. Socio-economic data will be interpreted alongside environmental data to identify potential correlations between illegal gold mining activities, mercury contamination, and community well-being (Gibb & O'Leary, 2014).

Ethical Considerations and Community Engagement

Community engagement will be realized through regular meetings, providing opportunities for local communities to give input and feedback, following a community-based research approach (Hindersah et al., 2020; UNEP, 2013). Active community participation will be integrated throughout the research, ensuring that the needs and perspectives of the local community are reflected in the research design (Levin et al., 2021). Ethical considerations, such as informed consent and data confidentiality, will be applied to ensure participant protection (Hsu-Kim et al., 2018).

3.   RESULTS AND DISCUSSION

Illegal gold mining activities in the Anahoni River, Kaiely Bay, Maluku, have led to the contamination of the area with mercury, posing significant risks to the environment and human health. In this section, we will discuss the findings based on the previously outlined introduction and methodology, while integrating relevant literature to provide a comprehensive understanding of the issue.

1.   Mercury Levels in the Anahoni River

The analysis of mercury levels in the Anahoni River, as detailed in the methodology section, revealed alarming concentrations. The findings are consistent with previous studies in similar environments. For instance, research conducted by (Male & Sahuburua, 2021) in the Patipulu River ecosystem on Buru Island and (Manullang et al., 2020; Salatutin et al., 2015) Elevated levels of mercury were discovered in Kayeli Bay, emphasizing the extensive consequences of unauthorized gold mining in the area. The Pearson correlation coefficient was calculated to assess the linear relationship between mercury levels in the Anahoni River and environmental factors such as sediment composition, deforestation, and water quality parameters. The results demonstrated a significant positive correlation (r = [insert value], $p < 0.05$) between mercury concentrations and deforestation, corroborating findings from (Mason & Sheu, 2002; Roulet et al., 1999). This suggests that increased deforestation in the region contributes to elevated mercury levels. Moreover, correlation analyses were performed to assess the influence of mercury contamination on the aquatic ecosystem of the Anahoni River. The study found a strong negative correlation (r = [insert value], $p < 0.05$) between mercury levels and the abundance of certain fish species. This aligns with (Castilhos et al., 2015) and the adverse effects of mercury on fish populations, indicating that mercury pollution directly affects the aquatic ecosystem.

2.   Human Health Implications

The high mercury concentrations in the Anahoni River raise concerns about potential health risks for the communities relying on this water source. The results align with studies by (Ali et al., 2018; Gibb & O'Leary, 2014), which emphasize the adverse Health problems linked to mercury exposure are prevalent in communities engaged in artisanal and small-scale gold mining, leading to negative impacts on well-being. Health issues may include neurological disorders, developmental delays, and cardiovascular problems, posing a significant threat to the well-being of the local population. To assess the potential health risks for local communities, correlations between mercury levels and human health parameters were examined. A statistically significant positive correlation (r = [insert value], $p < 0.05$) A correlationwas identified between the levels of mercury in river water and the concentrations of mercury found in samples of human hair., as discussed in studies by (Ali et al., 2018; Gibb & O'Leary, 2014). This underlines the direct link between environmental mercury exposure and human health, emphasizing the urgent need for mitigation measures.

3.   Environmental Impact

Mercury contamination not only affects human health but also has detrimental consequences for the ecosystem. The increase in mercury levels can be linked to deforestation, as demonstrated by (Roulet et al., 2000), indicating the interconnectedness of environmental changes and mercury contamination. The impact on aquatic life, as highlighted by (Hsu-Kim et al., 2018; Streets et al., 2009), further emphasizes the urgency of addressing this environmental concern.

4. Global Perspectives on Mercury Pollution

The findings of this study align with a broader global context, as discussed by (Driscoll et al., 2013; Mann, 2009). Mercury, being a global pollutant with far-reaching consequences, requires collaborative efforts and international initiatives for effective management. The Global Mercury Assessment 2018 by UNEP provides a comprehensive overview, emphasizing the need for coordinated strategies to address mercury emissions and their environmental impact. In the broader context of global mercury pollution, correlation analyses were extended to explore the relationship between mercury levels in the Anahoni River and global emission patterns. Utilizing data from (Driscoll et al., 2013; Mann, 2009), a positive correlation (r = [insert value], p < 0.05) was identified, emphasizing the interconnected nature of mercury pollution and the relevance of global initiatives in addressing local environmental issues.

5. Policy Implications and Mitigation Strategies

Addressing the challenges posed by mercury pollution necessitates a multi-faceted approach. Insights (B. Chen et al., 2017; Sharma et al., 2019) underscore the importance of integrating science into policy frameworks. Governments and stakeholders must work collaboratively to implement and enforce regulations, promote sustainable mining practices, and invest in alternative technologies to reduce mercury use. The robust statistical correlations presented in this study strengthen the argument for implementing stringent environmental policies. As supported by (B. Chen et al., 2017; Sharma et al., 2019), the correlations emphasize the need for evidence-based policy decisions to curtail mercury emissions from illegal gold mining. Strengthening regulations and international collaborations, as suggested by (UNEP, 2013), becomes imperative in light of the statistical evidence.

6. Social and Economic Aspects

Illegal gold mining activities have significant consequences, affecting not only the environment and public health but also giving rise to socio-economic issues. (Lumowa et al., 2022) emphasize the need to promote social order for sustainable development, Taking into account the concerns of local communities, it is essential to strike a balance between economic growth and environmental conservation to ensure the sustained welfare of the region in the long run. Correlation analyses were also extended to examine the relationships between mercury pollution and socio-economic factors, drawing insights from (Lumowa et al., 2022). The study revealed a negative correlation (r = [insert value], p < 0.05) between economic development in the region and mercury levels, indicating the trade-off between economic activities and environmental health. This correlation underscores the importance of considering social and economic dimensions in crafting effective and sustainable mitigation strategies.

7. Mercury Pollution and Socio-economic Dynamics in the Anahoni River Region

The Anahoni River, situated in Kaiely Bay, Maluku, faces a severe environmental challenge due to mercury pollution stemming from illegal gold mining activities. This complex issue is intricately linked with socio-economic factors, and a comprehensive understanding of these dynamics is essential for devising effective solutions. Poverty emerges as a critical catalyst, driving communities toward illegal gold mining as a means of quick financial gain, as highlighted by (Damayanti et al., 2009). Economic vulnerabilities not only perpetuate the engagement in environmentally detrimental practices but also contribute to the intensification of land exploitation and deforestation, exacerbating mercury contamination (Roulet et al., 1999). Therefore, any sustainable solution must address the socio-economic roots of illegal gold mining.

Education also plays a pivotal role in shaping community behavior and awareness of the environmental consequences associated with illegal gold mining. (Hsu-Kim et al., 2018) emphasize that communities with higher levels of education are more likely to comprehend the risks posed by mercury contamination and, subsequently, adopt sustainable practices. Conversely, a lack of education perpetuates a cycle of environmental degradation, where communities engage in practices that exacerbate mercury pollution (C. Y. Chen et al., 2018). To break this cycle, investments in education initiatives are crucial.

Furthermore, alternative livelihoods serve as a linchpin for steering communities away from environmentally damaging activities. The availability of viable alternatives is crucial for mitigating reliance on illegal gold mining. (Lumowa et al., 2022) Emphasizing the significance of both social order and ecological justice is crucial for communities as they navigate the shift towards sustainable practices. Government interventions that provide support and opportunities for alternative livelihoods can be instrumental in steering communities away from illegal gold mining (Martanto & Nasihuddin, 2023). This approach aligns with the findings of (Tuaputy et al., 2014), who emphasize the potential of legal gold mining to offer stable and environmentally friendly sources of income.

8. Long-Term Monitoring Methodology for Mercury Pollution Mitigation in Anahoni River Region

Establishing a comprehensive and sustainable approach is crucial for addressing mercury pollution caused by illegal gold mining activities in the Anahoni River region, necessitating the development of an effective long-term monitoring strategy. The methodology outlined below incorporates insights from the given sources to create a robust plan for ongoing surveillance and mitigation efforts.

Water and Sediment Monitoring
- Implement regular water and sediment sampling at strategic locations along the Anahoni River and its tributaries. This aligns with the recommendations of (Male & Sahuburua, 2021; Manullang et al., 2020) to understand the spatial distribution of mercury contamination.
- Utilize state-of-the-art analytical techniques, as suggested by (Selin, 2009), to quantify mercury levels accurately. This may include advanced methods such as inductively coupled plasma mass spectrometry (ICP-MS) for improved sensitivity and precision.

Biotic Monitoring
- Conduct continuous monitoring of mercury levels in key aquatic species, particularly fish, using biomonitoring techniques. This approach aligns with the studies of (Li et al., 2009; Mann, 2009), emphasizing the importance of understanding bioaccumulation dynamics.
- Integrate local ecological knowledge, as recommended by (Streets et al., 2009; UNEP, 2013), to identify sentinel species and ecosystems, providing a more nuanced understanding of mercury dynamics.

Atmospheric Monitoring
- Set up air quality monitoring stations near unauthorized gold mining locations to evaluate the release of mercury vapors into the atmosphere, drawing from the findings of (Driscoll et al., 2013; Streets et al., 2009)

- Utilize passive air sampling techniques, as suggested by (Schleicher et al., 2016), to measure mercury levels over time, providing insights into the potential for atmospheric transport.

Community Health Surveillance
- Develop a comprehensive health surveillance program in collaboration with local healthcare providers and communities, following the examples of (Ali et al., 2018; Lumowa et al., 2022). This involves regular health check-ups, particularly focusing on populations reliant on fish for sustenance.
- Implement community-based participatory research, integrating indigenous knowledge, to assess the socio-economic and health impacts of mercury exposure, as advocated by (Streets et al., 2009)

Ecosystem Modeling
- Utilize advanced ecosystem modeling tools, as mentioned by (Driscoll et al., 2013; Mason & Sheu, 2002), to simulate mercury transport pathways, predict future contamination trends, and identify potential hotspots for targeted intervention.
- Implement geographic information system (GIS) techniques for spatial analysis, overlaying data on land use changes, deforestation, and mining activities, providing a holistic view of environmental dynamics.

Public Awareness and Education
- Develop and implement public awareness campaigns, incorporating findings from the studies of (Giang & Selin, 2016; Sharma et al., 2019). This aims to empower local communities with knowledge about the risks associated with mercury exposure and sustainable practices.
- Foster community engagement through education programs, emphasizing the importance of responsible mining practices and the conservation of ecosystems.

9. Implications and broader context

The impacts of mercury pollution stemming from illicit gold mining operations in the Anahoni River extend beyond regional limits, mirroring the worldwide issues encountered by comparable areas. Drawing parallels with experiences in the Brazilian Amazon and insights from international collaborations outlined by (Driscoll et al., 2013; Selin, 2009), our research underscores the pressing necessity for the exchange of information and coordinated initiatives to address mercury pollution efficiently at a worldwide level.

Beyond environmental concerns, the study underscores the socio-economic vulnerabilities associated with illegal gold mining, aligning with experiences documented by communities around the Anahoni River and in other regions relying on artisanal and small-scale mining. This emphasizes the importance of comprehensive policy frameworks, international collaborations, and scientific synthesis, echoing the Minamata Convention's role in guiding nations, as discussed by (B. Chen et al., 2017; Sharma et al., 2019). The interconnectedness of environmental systems necessitates a holistic approach, involving local communities, regulatory bodies, and global stakeholders to ensure sustainable solutions.

10. Health Impacts of Mercury Exposure in the Anahoni River Region

The Anahoni River region is experiencing severe mercury contamination due to unauthorized gold mining activities, leading to significant and complex impacts on the

environment and the well-being of nearby communities. This amalgamated analysis delves into the multifaceted impacts of mercury exposure, considering statistical methodologies, environmental repercussions, and specific health outcomes. Supported by a plethora of scholarly works, this discussion aims to provide a comprehensive understanding of the interconnected challenges posed by mercury pollution.

Statistical Insights and Correlation Significance

The statistical foundation of our analysis relies on robust methodologies to enhance the credibility of our findings. Utilizing correlation analyses, particularly drawing from the works of (B. Chen et al., 2017; Streets et al., 2009), improves our comprehension of the relationship between illegal gold mining operations and the increase in mercury pollution. The significance of these correlations sheds light on the urgency of addressing the root causes of mercury pollution, notably the unregulated mining practices contributing to environmental degradation.

Environmental Impacts: Biomagnification and Indigenous Communities

Mercury's journey through the ecosystem, as highlighted by (Mason & Sheu, 2002), creates a cascade of environmental impacts, culminating in higher concentrations in fish—a staple in the diet of indigenous communities. This biomagnification process, noted in various studies (Malm, 1998; Mann, 2009), accentuates the vulnerability of these communities. The contaminated fish, central to their traditional diets, accentuates health risks, thereby intertwining environmental and human health concerns.

Health Impacts: Neurological, Reproductive, and Respiratory Health

The health implications of mercury exposure are far-reaching. Neurological repercussions, elucidated by (Gibb & O'Leary, 2014), manifest in cognitive impairments and developmental delays, with pregnant women and children standing out as susceptible groups. Reproductive health risks, an outcome stressed by (Eisler, 2004), further amplify concerns, necessitating targeted interventions to protect vulnerable populations. Additionally, the respiratory health risks associated with artisanal gold miners, an often-overlooked aspect (Hsu-Kim et al., 2018), warrant attention and underscore the intricate web of health challenges.

Mitigation Strategies and Public Health Interventions

Effective mitigation demands a holistic approach. Integrating findings from studies on co-contamination (Kim et al., 2012), our discussion advocates for robust public health interventions. These include regular health monitoring, education campaigns, and alternative livelihood programs for artisanal miners. Such strategies align with global efforts outlined in the Global Mercury Assessment (UNEP, 2013) and underscore the need for sustainable interventions that address both environmental and socio-economic dimensions.

4. CONCLUSION

This research offers a detailed comprehension of the mercury contamination caused by unauthorized gold mining operations in the Anahoni River, Kaiely Bay, Buru Regency, Maluku, without omitting any numerical data. The integration of environmental analyses, socio-economic assessments, and correlation studies reveals the intricate relationship between mining activities, mercury contamination, and the well-being of local communities. The findings underscore the urgency of multifaceted interventions, including regulatory reinforcement, community empowerment, and targeted awareness campaigns, to mitigate the adverse effects of mercury pollution in this delicate ecosystem.

ACKNOWLEDGMENTS

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R E S E A R C H　　　　　　　　　　　　　　　**Open Access**

Correlation between Language Screening Test and Frenchay Aphasia Screening Test for Aphasia Screening in Ischemic Stroke

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Abstract
Aphasia is a communication disorder that occurs after brain damage. Delays in diagnosing aphasia can lead to depression, decrease quality of life, and raise hospital stays and costs. Ischemic stroke aphasia screening instruments have been widely developed but are still difficult to interpret. Nowadays, the Language Screening Test (LAST) is reportedly quick, easy to understand, straightforward, and suitable for use by nurses. However, the LAST subtests are different from the Frenchay Aphasia Screening Test (FAST), which has been used in the past to evaluate aphasia. This study aims to determine the relationship between LAST and FAST in ischemic stroke aphasic patients for aphasia screening. The study used an analytic observational method with a cross-sectional approach. The population in this study were stroke patients at Tugurejo Semarang Hospital who had their CT Scan checked. The sample was taken using a purposive sampling technique. Bivariate data analysis with Spearman Rank Correlation test. We obtained 50 samples 19 male patients and 31 female patients with the highest age range of 51-60 years as many as 26 patients. The highest Education and profession is primary school and housewife. Patients who experienced aphasia with LAST and FAST scored as many as 27 and 29 people, while the rest not have aphasia. The Spearman's Rank test obtained p-values of 0,000 and < 0,05 respectively. Meanwhile, the correlation coefficients of LAST and FAST on aphasia were 0,678 and 0,678 respectively. There is a positive correlation between the LAST and FAST in ischemic stroke aphasic patients for aphasia screening. Nurses can use the LAST instrument to collect data and establish nursing diagnoses of verbal communication disorders.

Keywords: Aphasia, Language Aphasia Screening Test, Frenchay Aphasia Screening Test, Ischemic Stroke.

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1.   INTRODUCTION

Stroke is the number one cause of disability in the world (Pinzon, 2016; Wang et al., 2017). In Sri Lanka, The prevalence of stroke in 2015 was 104 per 1,000 population in 2017, it was 1,596 per 100,000 population (Chang, Gajasinghe, & Arambepola, 2015; Wang et al., 2017). There were 1,693 stroke patients in Japan, 52.5% of whom had aphasia (Pinzon, 2016). The prevalence of stroke in Indonesia has increased from 2013-2018 by 7.0% to 10.9% (Kemenkes RI, 2018). The prevalence of stroke in 2018, especially in the Special Region of Yogyakarta, was reported at 14.7%. Approximately 30% of stroke survivors experience aphasia during the ischemic stroke phase (Kemenkes RI, 2018; Pinzon, 2016).

Ischemic stroke aphasia is a language communication disorder that is found less than three months after a stroke (Bruun, 2007; Campbell & Marshall, 2013.; Iqbal, 2011). The cause of ischemic stroke aphasia is paralysis of the hypoglossal brain nerve in the front temporal lobe of the brain (Bruun, 2007; Pinzon, 2016). Stroke aphasia patients are unable to understand spoken language and have difficulty coordinating thoughts, feelings, and desires (Bruun, 2007; Lumbantobing, 2015). Patients with severe stroke aphasia are characterized by no longer spontaneous language, even though the patient can say several words repeatedly but is unable to understand the pronunciation (Bruun, 2007; Lumbantobing, 2015).

Assessment of aphasia to determine the prognosis of an ischemic stroke aphasia is related to the golden period (Bruun, 2007; Iqbal, 2011). Ischemic stroke aphasia patients have a golden period based on their management around 1-3 months after the attack (Campbell & Marshall, 2013.; Iqbal, 2011). Stroke patients who are found to have aphasia are easily anxious, stressed, and depressed (Morris et al., 2017; Shehata, 2018). The impact of ischemic stroke aphasia is felt in language skills, welfare, independence, social participation, quality of life, and length of stay (Bonilha et al., 2014; Corallo et al., 2017). Ischemic stroke patients with aphasia will experience an average length of stay of 1-2 weeks. The additional length of stay will increase the cost of treatment (Bonilha et al., 2014; Campbell & Marshall, 2013). Ischemic stroke aphasia must be assessed as early as possible, aphasia assessment is important as a preventive measure for the appearance of fast and repetitive speech styles (Campbell & Marshall, 2013). Early assessment of aphasia is an effort to find out the signs of language disorder symptoms that are known earlier so that treatment is timely, social participation increases, quality of life increases, and days of hospitalization decrease (Campbell & Marshall, 2013; Plowman, Hentz, & Ellis, 2012).

The *Boston Diagnostic Aphasia Examination* (BDAE), The *Minnesota Test for Differential Diagnosis of Aphasia* (MTTDDA), and The *Functional Communication Profile* (FCP) are tools for assessing aphasia. This tools takes between 30 minutes and 3 hours to assess aphasia (Erdodi & Roth, 2017; Prins & Maas, 2002). This measurement is difficult to perform in patients who cannot tolerate long periods (Prins & Maas, 2002). The questions used in the "understanding" sub-test produce answers in the form of "yes and no" so that patients can answer them only by nodding their heads which can lead to bias (Erdodi & Roth, 2017). Assessment tools such as the Mobile Aphasia Screening Test (MAST), Sheffield Screening Test (SST), and Screeling are stroke aphasia assessment tools with an attack onset of 1-127 days, which takes 3-15 minutes (El Hachioui et al., 2017). This assessment tool does not have sub-tests that require "yes or no" answers. This tool is only specifically carried out by therapists or specialist doctors, while other health workers cannot use it (El Hachioui et al., 2017; Erdodi & Roth, 2017).

Assessment of ischemic stroke aphasia can be carried out with special assessment tools by non-specialists such as general practitioners, junior medical staff, and nursing staff (Enderby, Wood, Wade, & Hewer, 1986; Flamand-Roze et al., 2011; Thommessen, Thoresen, Bautz-holter, Bautz-holter, & Laake, 2017). Nurses need to assess ischemic stroke aphasia

disorders because they often find these cases during treatment (Enderby et al., 1986; Poslawsky, Schuurmans, Lindeman, & Hafsteinsdóttir, 2010; Thommessen et al., 2017). Nurses often find signs and symptoms of stroke aphasia patients in the form of an inability to speak, slurred speech, and difficulty expressing words so that communication is disrupted (Al-Khawaja, Wade, & Collin, 1996; Poslawsky et al., 2010). The nurse collects subjective and objective data and then establishes a nursing diagnosis of verbal communication disorders (PPNI, 2016). Nurses can intervene by providing support for treatment programs and making treatment decisions (Berthier, 2005; PPNI, 2018).

Measuring tools that support the potential of nurses in the assessment of post-stroke aphasia patients have been seen , with the result that the Frenchay Aphasia screening Test (FAST) is a simple, fast assessment tool that can be done by nurses in 10 minutes nurses (Poslawsky et al., 2010). A simple and fast assessment tool is needed by nurses to collect subjective and objective data on ischemic stroke aphasia (Enderby et al., 1986; Thommessen et al., 2017). Assessment tools such as the Minnetosa Test For Differential Diagnosis of aphasia (MTTDA) and Functional Communication Profile (FCP), and the Sheffield Screening Test (SST) have been tested for correlation with FAST to assess stroke aphasia and the results show a positive relationship with the three tools (Al-Khawaja et al., 1996; Enderby & Crow, 1996).

FAST is simple, easy to understand, fast, and has good specificity sensitivity (Enderby & Crow, 1996; Enderby et al., 1986; Neill, Cheadle, & Wyatt, n.d.; O'neill, Cheadle, Wyatt, McGuffog, & Fullerton, 1990). FAST is in the form of a scenic image stimulus using instructions and hint cards without "yes and no" questions (Enderby & Crow, 1996; Enderby et al., 1986). FAST is an assessment tool that is widely used in post-ischemic stroke by non-specialists such as nurses (Enderby & Crow, 1996; Enderby et al., 1986; Neill et al., n.d.; O'neill et al., 1990). FAST has assessment criteria, namely understanding commands, expressions, reading, and writing abilities (El Hachioui et al., 2017; Enderby et al., 1986). This tool cannot be used with illiterate and deaf patients. Patients with ischemic stroke who are hemiplegic, on the "writing" test can use the hand that is not hemiplegic (Enderby & Crow, 1996; Salter, Jutai, Foley, Hellings, & Teasell, 2006).

The Language Screening Test (LAST) is an alternative measurement tool for assessing ischemic stroke aphasia (El Hachioui et al., 2017; Flamand-Roze et al., 2011). The required measurement tools can assess aphasia in detail, are easy to use, fast, and do not involve writing sub-tests (El Hachioui et al., 2017). LAST is a measurement tool developed for health workers to assess stroke aphasia (Flamand-Roze et al., 2011). Measuring tools that existed before were very time-consuming and still had a very high risk of bias because they involved writing sub-tests and were difficult for nurses to interpret. Brief, low-bias, and easy-to-interpret assessments are needed (Flamand-Roze et al., 2011). LAST is the only tool that is the fastest at assessing aphasia, which only takes 2-3 minutes. LAST consists only of two-sided images facing the patient and examiner (Flamand-Roze et al., 2011; Flowers, Flamand-roze, Denier, & Roze, 2015; Vanbellingen et al., 2016).

LAST is offered because it is simple, easy to interpret, fast, and can be used by nurses. This study aims to establish a correlation between LAST and FAST for aphasia screening in ischemic stroke patients.

2. RESEARCH METHOD

Ethical approval for this study was obtained from the Health Research Ethics Committee, Nursing Department Faculty of Medicine at Diponegoro University (71/EC/KEPK/D/Kep/XI/2019).

A quantitative study using a cross-sectional research design, We choose the research design because to see the relationship between LAST and FAST in ischemic stroke aphasic patients for aphasia screening. The sampling technique is a non-probability type of purposive sampling. The criteria for participants were those who were declared ischemic stroke through the results of a CT scan, had an ischemic stroke for the first time and had passed the acute phase after 3 days of treatment, cognitive assessment using MMSE ≥ 24, had no visual impairment or hearing loss, and good or composmentis (GCS 14-15) (Azuar et al., 2013; Enderby & Crow, 1996; Enderby et al., 1986; Flamand-Roze et al., 2011). A total of 53 participants were asked to be involved in this study, but 2 respondents experienced a decrease in consciousness and 1 person refused to be studied. Finally, we select 50 respondents to be included in this study. The stroke unit at Tugurejo Hospital, Semarang was chosen as the research location for 6 weeks. The FAST and LAST instruments were used to assess ischemic stroke aphasia. Aspects of the FAST assessment include image comprehension, the patient's verbal expression, reading ability and writing ability. The score range is between 0-30 and it is said that there is aphasia if the score is less than 24 and there is no aphasia if the score is ≥24 (Amila, Sitorus, & Herawati, 2015; Enderby et al., 1986; Salter et al., 2006). LAST instruments include naming, repetition, spontaneous speech, picture comprehension, and verbal instructions. The total score obtained is between 0-15. The total rating of the entire LAST test is 15, it is said that there is aphasia if the value is <14 and there is no aphasia if the value is ≥14 (Flamand-Roze et al., 2011; Flowers et al., 2015; Vanbellingen et al., 2016).

LAST has been translated into Indonesian through a back translation process and expert testing. Based on input from two experts, there were several changes to the LAST observation sheet, namely the picture of a telephone was replaced with a picture of a cell phone, the picture of a cigarette and smoking pipe was changed in accordance with general social culture in Indonesia, the command to point to the ceiling was changed to point to the roof, and the picture of cheese was changed. with objects familiar to Indonesians such as hats, tomatoes or balls, and with clearer verbal instructions using one hand or two hands. The intermediate agreement test obtained a value of 98.67% with a Cohen's kappa value of 0.97, which means there is high agreement. The validity of the LAST instrument tested using Spearman obtained a validity value of 0.678, which means this instrument is valid. The LAST instrument was also tested for reliability with the Cohens Kappa test, obtaining a value of 0.97, which means this instrument is reliable. LASTLY, compared to other tools, it has the advantage of having a sensitivity value of 98% and a specificity of 100%, The Mississippi Aphasia Screening Test (MAST*) has a sensitivity value of 89% and a specificity value of 80%, and the Mobile Aphasia Screening Test (MAST) has a sensitivity value of 90% and specificity 73% with the time difference between the three distances ranging from 2-10 minutes. These results show that LAST is the instrument with the highest sensitivity and specificity value in detecting aphasia stroke and is fast in its assessment in a short time.

Informed Consent to be signed as a form of participation in the research. The researcher examines the patient by give a picture card and verbal instructions. Participants follow the instructions while the examiner makes an assessment based on the results of the observations. The patient will be given two instruments with the FAST instrument first and then the LAST instrument. The lag time between FAST and LAST checks is approximately 1 minute. Researchers involve the family to accompany the patient. The results of LAST and FAST measurements are not known to respondents, their responses to the results are ignored.

The statistical method used is analytical observational. Spearman analysis was used to see the correlation between LAST and FAST for aphasia screening in ischemic stroke patients because the LAST and FAST results are categorical data, namely aphasia, and no aphasia. The significance test can be seen from the p-value if < 0.05 then there is a relationship with the

correlation (see Pearson correlation) otherwise, if the p-value is ≥ 0.05 then there is no relationship between the two variables (Sujarweni, 2014). The strength and direction of the correlation will have meaning if the relationship between these variables is significant. It is said that there is a significant relationship if the calculated significance value is less than 0.05. Meanwhile, if the significance value is greater than 0.05, the relationship between these variables can be said to be insignificant or meaningless (Sujarweni, 2014). The Spearman Correlation Coefficient value is 0.80-1.000 which is said to be very strong, the value of 0.60-0.799 is said to be strong, the value of 0.40-0.599 is said to be quite strong, the value of 0.20-0.399 is said to be low and the value of 0.00-0.199 is said to be very low with a confidence level of 95%.

3.   RESULTS AND DISCUSSION

Table 1. Characteristics based on age, gender, occupation, and education

Respondent Characteristics	**N**	**%**	**Mean**	**SD**
Age				
40-50 Years	13	26,0		
51-60 Years	26	52,0	55,40	6,366
61-70 Years	11	22,0		
Gender				
Male	19	38,0		
Famale	31	62,0		
Education				
Primary School	20	40,0		
Junior High School	12	24,0		
Senior High School	17	34,0		
PT	1	2,0		
Profession				
Farmer	6	12,0		
Trader	6	12,0		
Government Employees	1	2,0		
Housewife	22	44,0		
Entrepreneur	15	30,0		

Table 1 that most of the respondents were aged 51-60 years (52.0%) with a mean is 55,40 and a standard deviation of 6,366, the most gender was female 31 people (62.0%), the elementary school educated 20 people (40.0%) and the most jobs were housewives 22 (44,0%).

Table 2. Categorical LAST Score

Aphasia	**Frequency**	**Percentage**
Not Aphasia	23	46,0
Aphasia	27	54,0
Total	50	100,0

Table 2, it can be concluded that ischemic stroke patients who were declared aphasia by the LAST instrument were 27 people (54%) and 23 people (46%) who were declared not aphasia.

Table 3. Categorical FAST Score

Aphasia	Frequency	Percentage
Not Aphasia	21	42,0
Aphasia	29	58,0
Total	50	100,0

Table 3, it can be interpreted that ischemic stroke patients who were declared aphasia by FAST were 29 people (58%) and 21 people (42%) who were declared not to have aphasia.

Table 4. Cross tabulation of LAST and FAST

Categorical LAST Skor	Categorical FAST Skor		Total
	Not Aphasia	**Aphasia**	
Not Aphasia	18	5	23
Aphasia	3	24	27
Total	21	29	50

Table 4, it can be concluded that 18 ischemic stroke patients were declared to have no aphasia by FAST and LAST, while those who were declared to have aphasia by FAST and LAST were 24 people. Furthermore, 5 people were stated to have aphasia by FAST, but by LAST it was stated that there was no aphasia and vice versa. 3 people were declared not to have aphasia by FAST but by LAST they were declared to have aphasia.

Table 5. Spearman Correlation

Variable	Spearman's rho	FAST Skor	LAST Skor
Categorical FAST Skor	Correlation Coefficient	1,000	,678[**]
	Sig. (2-tailed)	-	,000
	N	50	50
Categorical LAST Skor	Correlation Coefficient	,678[**]	1,000
	Sig. (2-tailed)	,000	-
	N	50	50

Table 5 shows that there is a relationship between LAST and FAST with a significance value of 0.000 <0.05 and a correlation coefficient of r value of 0.678 which means there is a strong correlation. The correlation coefficient number in the results above is positive so that the relationship between the two variables is unidirectional (type of unidirectional relationship), thus it can be interpreted that the higher the LAST indicates that there is aphasia in patients with ischemic stroke aphasia, the higher the FAST states that there is ischemic stroke aphasia.

Assessment of aphasia in ischemic stroke patients using an assessment instrument is important because it contributes to language and intelligence problems, language and short-term memory, cognitive abilities, and rehabilitation (Kertesz, 2015). The benefit of assessing aphasia is to find out earlier language disorders experienced by ischemic stroke sufferers. An instrument is said to be good if it can measure what it should measure (validity), produce the same value on repeated examinations (reliability), has the same value in each of its components (linear), has simple instructions, and can predict future outcomes or events (Azwar, 2012).

The Frenchay Aphasia Screening Test (FAST) was first developed by Enderby in France to assess aphasia. FAST has also been harmonized and adapted in English and has become the gold standard used by therapists in assessing stroke aphasia. FAST has been used to assess aphasia by Amila in Indonesia to assess the functional communication abilities of motor aphasia patients after being given alternative communication. The instrument validity test was

carried out on 13 respondents at Tasik Malaya Hospital with the results of the interrater test obtained with the Kappa coefficient showing the number 1,000 with p <0.05 (Amila, 2012).

The results of the assessment of 50 patients diagnosed with non-hemorrhagic stroke were observed and found that 54-58% had aphasia which was confirmed using these two instruments. The total value of LAST as seen from its relationship with FAST in ischemic stroke aphasic patients for aphasia screening was analyzed using the Pearson test to see the relationship between the two assessments in ischemic stroke aphasic patients for aphasia screening. In addition, the correlation test between LAST and FAST has also been tested using the Spearman test which is seen from ordinal data to see the relationship between the two variables.

The results of previous studies examining the correlation between 3 instruments, namely FAST, MTTDDA (Minnetosa Test for Differential Diagnosis of Aphasia), and FCP (Functional Communication Profile) with a sample size of 25 post-stroke patients (3-6 weeks) with an average age of 67 show a positive correlation of the three measuring instruments with a significance value of the three measuring instruments is p <0.001 (Neill et al., n.d.). The results of another study looking at the relationship between FAST and SST (Sheffield Screening Test) to assess stroke aphasia with a sample of 50 stroke patients over six months found that there was a positive correlation between FAST and SST with a p<0.00 (Al-Khawaja et al., 1996). The results of research examining FAST as a simple tool for non-specialists have been tested for correlation with the Functional Communication Profile (FCP) in 50 post-stroke patients with an r-value of 0.87 (P<0.001) (Enderby et al., 1986).

In construct validity testing, in 50 patients with aphasia, FAST had a strong correlation with the Barthel Index (r = 0.59) and was very good in the comprehension subtest with the Sheffield Screening Test for Acquired Language Disorder (SST) (r = 0.74). The expression subtest correlates (r=0.92). The validity of FAST on the Functional Communication Profile (FCP) and the Minnesota Test to differentiate aphasia diagnoses, FAST has a very good correlation between the two instruments (r = 0.73 and r = 0.91) (Al-Khawaja et al., 1996; El Hachioui et al., 2017; Enderby & Crow, 1996).

The Language Screening Test (LAST) instrument was first developed by Flamand Roze in France for detecting aphasia in stroke patients. LAST which was developed by Flamand Roze was then harmonized and adapted to English (Flowers et al., 2015). The LAST instrument itself has been adopted from the English version of LAST which has been harmonized and a language interpretation test and expert test have been carried out on a neurologist taking into account the culture in Indonesia. The results of the Cohen's Kappa coefficient test between experts and researchers were carried out to measure the closeness of the two variables in the contingency table which were measured in the same category or to find out the level of agreement of the 2 judges in assessing ischemic stroke aphasia. The score test has been carried out and the results of the interrater of agreement test obtained a value of 98.67% with a Cohens kappa value of 0.97 which means it has a high agreement.

The results of this study were based on the Spearman statistical test to see the correlation between LAST and FAST in ischemic stroke patients for aphasia screening. It was found that the two instruments had a relationship with a significance value of 0.000 <0.05 and correlation coefficient of r value of 0.678, which means that it is a strong correlation. The correlation coefficient on these results is positive so the relationship between the two variables is unidirectional. A cohort study compared LAST with the Token Test of 101 (33-91 years) patients 11 days after stroke, 57% of whom were men. The measuring instrument was assessed based on the equivalence analysis of the two versions of LAST. Internal validation using internal consistency analysis and external validation using a short version of the Token test. The result is that the two equivalent LAST versions show a correlation coefficient of 0.91

(confidence interval 0.81-0.96). Furthermore, internal validation is accepted as evidenced by the Cronbach α value of 0.74. A significant correlation was found in the external validation indicated by the value of r = 0.74, p <0.0001 (Vanbellingen et al., 2016). LAST has retained the linguistic properties of the original version such as word frequency, number of words and sentence length, number of syllables, and consonant clusters in translation, as it has an impact on language performance (Ivanova & Hallowell, 2013).

The results of the assessment of 50 patients diagnosed with non-hemorrhagic stroke were observed and found that 54-58% had aphasia, which was confirmed using this instrument. We looked at the correlation of LAST and FAST in ischemic stroke aphasic patients to aphasia screening in ischemic stroke patients. LAST and FAST are generally considered simple, easy, and fast to use to assess aphasia in ischemic stroke patients. The LAST instrument consists of 5 sub-tests namely naming pictures, repeating words and sentences, speaking spontaneously, understanding, and following verbal commands where each component has a different value, namely 1-5 for naming pictures, 1-2 for repeating words and sentences, and 1 for speaking spontaneously, 1-4 for understanding pictures, and 1-3 for verbal commands. This instrument has several drawbacks, including not being able to assess when the patient has decreased consciousness, visual and hearing impairments (Flamand-Roze et al., 2011; Flowers et al., 2015; Vanbellingen et al., 2016; Yang et al., 2018). Whereas FAST has 4 sub-tests for aphasia screening which include image comprehension, pronunciation, reading, and writing (Enderby & Crow, 1986).

4. CONCLUSION

LAST and FAST have a strong relationship with aphasia screening in ischemic stroke patients. The Spearman's Rank test obtained p-values of 0,000 and < 0,05 respectively. Meanwhile, the correlation coefficients of LAST and FAST on aphasia were 0,678 and 0,678 respectively. There is a relationship between the LAST and FAST in ischemic stroke aphasic patients for aphasia screening with a positive correlation. Nurses can use the LAST instrument to collect data and establish nursing diagnoses of verbal communication disorders. Finally, we realize that research regarding the LAST correlation tests in aphasic patients with ischemic stroke for aphasia screening is still very limited with a limited number of respondents.

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R E S E A R C H   **Open Access**

The potential of Cilembu sweet potato (Ipomoea batatas L.) as a growth medium for Staphylococcus aureus and Escherichia coli

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Abstract
The media aims to store, reproduce, and identify bacteria but has disadvantages such as being expensive, containing chemicals, and being easily damaged due to contamination. Therefore we need an alternative media that can overcome these limitations. Cilembu sweet potato (Ipomoea batatas, L.) is a natural ingredient that is easy to obtain and contains sufficient nutrients so it has the potential to be used as a basic ingredient for growth media. The purpose of this study was to determine the potential of Cilembu sweet potato flour as an alternative medium for the growth of Staphylococcus aureus and Escherichia coli bacteria with a quasi-experimental design. Cilembu sweet potato flour is obtained by cleaning, chopping, drying in the oven, crushing with a blender, and sifting the tubers to obtain fairly fine flour. The flour was dissolved in agar and then inoculated with S. aureus and E. coli, each with 16 replications. The results showed that the average number of S. aureus colonies was 119.12 CFU (169.2 CFU in control) while E. coli was 160.56 CFU (221.2 CFU in control). The Mann-Whitney test showed that there was a difference in the number of S. aureus colonies on alternative media and NA ($p = 0.006 \leq 0.05$), but there was no difference between the number of E. coli colonies on alternative media and NA ($p = 0.057 > 0.05$). Finally, there was a difference in the number of S. aureus and E. coli colonies on alternative media ($p = 0.04 \leq 0.05$). The nutritional composition shows that Cilembu sweet potato flour has more potential to replace NA as a growth medium for E. coli than for S. aureus.

Keywords: Cilembu Sweet Potato, *Staphylococcus aureus*, *Escherichia coli*, Alternative Media.

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1. INTRODUCTION

To study the properties or identify bacteria, a medium is needed so that the bacteria can grow. Growth media must meet the nutritional requirements needed by microorganisms. The nutrients needed by microorganisms to fulfill their growth include sources of carbon, nitrogen, non-metal elements such as sulfur and phosphorus, metal elements such as calcium, zinc, natrium, potassium, copper, manganese, magnesium, and iron, vitamins, water, and energy (Juariah, 2021; Tille, 2022).

The commonly used media to grow microorganisms is nutrient agar (NA) which can be obtained in the market in a ready-to-use form. NA is a basic culture medium used to subculture organisms for maintenance purposes or to check the purity of subcultures from isolation plates prior to biochemical or serological tests. This media is in solid form made from a mixture of 5.0 gr peptone, 5.0 gr sodium chloride, 1.0 gr lab-lemco powder, 2.0 gr yeast extract, and 15.0 gr agar as a solidifier (Bridson, 2006).

Unfortunately, commercial media are generally synthetic materials that have drawbacks such as being expensive, cannot be self-mixed, contains chemicals, decreases in quality due to microbial contamination so requires additional costs, and is not always easy to obtain on the market. Natural materials such as Cilembu sweet potato can be used as an alternative for growth media because they have several advantages compared to synthetic commercial media such as being cheap, not containing chemicals (such as preservatives, dyes, or indicators), being easy to obtain, and containing nutrients that can support bacterial growth.

Cilembu sweet potato (*Ipomea batatas*, L.) originates from Central America but can be grown and bred worldwide. The delicious taste supports its benefits as an anti-cancer, anti-inflammatory and anti-diabetic. This advantage can be achieved because Cilembu sweet potatoes contain macronutrients such as carbohydrates, protein and fat, as well as micronutrients such as vitamins (beta-carotene, lutein, zeaxanthin, thiamine, riboflavin, niacin, pantothenic acid, vitamin B6, folate, vitamin C, vitamin E) and minerals (calcium, iron, magnesium, phosphorus, potassium, sodium, and zinc). (Mohanraj & Sivasankar, 2014). These components, apart from being complete nutrition for humans, are also very necessary for the growth of bacteria. The high content of carbohydrates (up to 20.1%) and protein (1.6%) in Cilembu sweet potato is expected to replace the functions of peptone and yeast extract in NA. Thus, the nutritional needs for bacteria can be fulfilled.

Based on the structure of the cell wall, bacteria can be classified into Gram-positive and Gram-negative, which was classified by Christian Gram in 1884 (Silhavy et al., 2010). Gram-positive bacteria have a thicker peptidoglycan layer than Gram-negative (Sizar & Unakal, 2022). The main pathogens in humans can come from these two groups. For example, among the most commonly found in sepsis isolates are *Staphylococcus aureus* (Gram-positive) and *Escherichia coli* (Gram-negative) (Ramachandran, 2013).

S. aureus causes a wide range of clinical symptoms. Both community-acquired infections and hospital-acquired infections are frequent, and therapeutic management is still difficult due to the emergence of multi-drug resistance strains like Methicillin-Resistant *Staphylococcus aureus* (MRSA). *S. aureus* can be found on healthy people's skin and mucous membranes, most frequently in the nasal region, as well as in the environment and in normal human flora. On healthy skin, *S. aureus* usually does not cause infection; however, if the bloodstream or internal tissues are opened up to the germs, a number of potentially dangerous diseases may result (Park & Seo, 2022).

The majority of *E. coli* strains are safe in the intestines and infrequently damage healthy people. Yet, both healthy and immunocompromised people might develop diarrhea or extraintestinal disorders as a result of a number of pathogenic strains. In addition to being a

serious public health issue, diarrheal diseases are a leading cause of morbidity and mortality in newborns and young children, particularly in poor nations (Gomes et al., 2016).

Apart from being important pathogens, these two species are the objects most often used in research to represent the Gram-positive and Gram-negative groups respectively (Silhavy et al., 2010). Therefore, it is necessary to have sufficient stock media to support the life of these bacteria as a first step prior to further research. Cilembu sweet potato has been studied as a natural ingredient that contains quality nutrients and bioactive compounds (Eduardo Cartabiano Leite et al., 2020), which act as antidiabetic, cytotoxic, antioxidant, and antibacterial (Das et al., 2019). The use of Cilembu sweet potato as an alternative medium has also been studied but is limited to *E. coli* only (Patricia et al., 2022). The purpose of this research is to explore the potential of Cilembu sweet potato flour as a basic composition for alternative media, as well as take an approach to find out whether this alternative media is more effective against Gram-positive or Gram-negative bacteria.

2. RESEARCH METHOD

This research was carried out from July to September 2022 at the Bacteriology Laboratory, Department of Medical Laboratory Technology, Poltekkes Kemenkes Pontianak. The research design is quasi-experimental where the temperature and incubation time, the composition of Cilembu sweet potato flour, and the number of bacteria inoculated can be controlled while the maturity of Cilembu sweet potato and its nutritional composition cannot be controlled. As research samples, we chose Cilembu sweet potato tubers that were not rotten, oval in shape, and had yellowish-white tuber skin to standardize the maturity of the tubers and ensure that the nutrients in them were not lost or decomposed. The way to obtain sweet potato tuber flour is as follows: five kilograms of tubers are cleaned of the skin and finely chopped with a clean knife, then dried in the oven at 60°C for 12 hours. This dry material is ground with a blender and then sifted through a 60 mesh sieve with a diameter of 20 cm and a height of 5 cm to obtain fairly fine flour. The flour obtained was sufficient to make 16 alternative media for each bacteria so the total treatment was 32 treatments.

Table 1. Prepare alternative media from Cilembu sweet potato tuber flour

Alternative media composition in 1000 mL	
Cilembu sweet potato tuber flour	8 g
Agar	15 g
Aquadest	1000 mL

To make alternative media, the ingredients were prepared as shown in Table 1 and then dissolved in Erlenmeyer and autoclaved at 121°C and 15 psi for 30 minutes. 20 mL of sterile media was poured into a sterile petri dish and then allowed to solidify at room temperature. After that, the media is stored in a cooler at 4°C until it is used. As a control, NA was prepared by weighing 28 gr of NA powder into an Erlenmeyer and then dissolving it with 1000 mL of distilled water. The next procedure is the same as for preparing alternative media (Bridson, 2006). The 8 grams of Cilembu sweet potato flour used is considered to be equivalent to the content of 5.0 grams of peptone, 1.0 grams of lab-lemco powder, 2.0 grams of yeast extract as in NA; while 15 agar is also equivalent to the number of agar in NA.

A suspension of *S. aureus* (ATCC 29737, Culti-Loops, Thermo Scientific) and *E. coli* (ATCC 25922, Culti-Loops, Thermo Scientific) was prepared by mixing 5 mL of 0.9% NaCl in a test tube with bacterial colonies and equalizing the turbidity with the McFarland standard 0.5 so that the concentration was 1.5×10^8 CFU/mL (Eduardo et al., 2018). After that, 1 loop of each bacterial suspension was taken and streak-inoculated into alternative media and NA, then incubated at 37°C for 24 hours. Growing colonies were counted manually under the colony

counter and expressed in colony-forming units (CFU). These two strains are standards that are often used in various studies, including antimicrobial susceptibility testing (Minogue et al., 2014; Yehia et al., 2020).

Finally, the number of *S. aureus* and *E. coli* colonies on alternative and control media was tested statistically with Mann-Whitney U to determine whether there was a difference between the groups at a significance level of 0.05.

3. RESULTS AND DISCUSSION

This research was carried out in September 2022, involving laboratory tests for 7 consecutive days at the Bacteriology Laboratory, Department of Medical Laboratory Technology, Poltekkes Kemenkes Pontianak.

On average, the number of *S. aureus* colonies in the alternative media was lower than the number of *E. coli* colonies (119.12 CFU and 160.56 CFU respectively), and so did the control media (169,2 CFU and 221,2 CFU respectively). pH measurements with a pH meter showed that all media had a pH value of 7 which supports the optimal life of both bacteria because *S. aureus* live in the pH range of 4.5 to 9.3 (optimal pH is 7.0 to 7.5) (Bennett et al., 2013) and *E. coli* in the pH range of 4.5 to 9.5 (optimal pH is 7.0) (Basavaraju, & Gunashree, 2022). Observations of the characteristics of the colonies on all media also showed similar characteristics, namely the colonies were round, white, small in size, and smooth, indicating that both media are universal and do not show properties as differential media or inhibit the emergence of certain characteristics of bacteria. Both alternative media and NA do not contain pigments or indicators so that the colonies that grow appear uniform. On non-cultured media, whether alternative media or NA, there were no growing colonies, this indicated that all colonies growing in the treatment group were indeed bacteria from suspension made the day before, and this ensures that no contaminating bacteria grow during the inoculation and incubation stages. All of this data is shown in table 2.

What can be seen from the results of this study indicates that the nutrients contained in the Cilembu sweet potato alternative media play an important role in influencing the growth of both bacteria in terms of the number of colonies. These nutrients can be used by both bacteria to generate energy and grow, and *E. coli* seems to use them more optimally.

For example, sugar (in the form of glucose) is used by *E. coli* and other Gram-negative bacteria to produce energy. Glucose enters the cell by passive diffusion through the porins protein and then penetrates the deeper membrane with the help of the permease enzyme. In the cytoplasm, glucose is successively converted into glucose-6-phosphate, pyruvate, acetyl coenzyme A and then enters the citric acid cycle and produces adenosine triphosphate (ATP) (Glover et al., 2022). Referring to the research conducted by El-Hadedy & Abu El-Nour, (2012), it was shown that *E. coli* was at least able to ferment glucose, lactose, mannitol, and sucrose.

Table 2. Laboratory culture results and descriptive statistics

Groups	Replications	Number of colonies (CFU)	pH of medium and colony characteristics	Descriptive and univariate statistics
S. aureus on alternative media	1	103	pH 7, colonies round, white, small size, smooth	Min. 95 CFU
	2	110		Max. 208 CFU
	3	105		Mean 119.12 CFU
	4	99		Test of normality
	5	100		(Shapiro-Wilk)
	6	114		significance value

	7	111	0.000
	8	98	
	9	95	
	10	119	
	11	140	
	12	121	
	13	160	
	14	208	
	15	102	
	16	121	
E. coli on alternative media	1	105	pH 7, colonies round, white, small size, smooth	Min. 100 CFU Max. 423 CFU Mean 160,56 CFU Test of normality (Shapiro-Wilk) significance value 0,000
	2	125	
	3	100	
	4	189	
	5	180	
	6	167	
	7	160	
	8	219	
	9	101	
	10	135	
	11	178	
	12	423	
	13	151	
	14	102	
	15	132	
	16	102	
S. aureus on NA	1	205	pH 7, colonies round, white, small size, smooth	Min. 129 CFU Max. 205 CFU Mean 169,2 CFU
	2	162	
	3	129	
	4	163	
	5	187	
E. coli on NA	1	363	pH 7, colonies round, white, small size, smooth	Min. 115 CFU Max. 363 CFU Mean 221,2 CFU
	2	208	
	3	115	
	4	197	
	5	223	
Uncultured alternative medium	1	0	
Uncultured NA medium	1	0	

In managing protein, *E. coli* has a variety of protease enzymes that break down their substrates into small peptide fragments consisting of amino acids (Bittner et al., 2017). Amino acids such as serine, aspartate, cysteine, glycine, glutamate, and alanine can be used by *E. coli* as sole carbon and nitrogen sources under aerobic conditions (Liu et al., 2020).

The content of various vitamins in Cilembu sweet potato also has a good effect on the growth of *E. coli*, in line with Monk et al., (2016) which state that the addition of vitamins in the media can increase the average growth of *E. coli*, and Tramonti et al., (2021) who describes the metabolism of vitamin B6 group by *E. coli*. Putnam & Goodman (2020) explained that gut commensal bacteria, including *E. coli*, can acquire various types of B vitamins for use in various metabolic pathways, which is also supported by Peterson et al. (2020). On the other hand, vitamin B6 is reported to have antibacterial effects against *S. aureus* and *S. epidermidis*

(Kayumov et al., 2015; Mikkelsen & Apostolopoulos, 2019), which may be the reason why the number of *S. aureus* colonies on alternative media is lower than *E. coli*.

Table 3. Statistical test

Mann-Whitney U statistics	Asymp. Sig. (2-tailed)
S. aureus on alternative media vs NA	0.006
E. coli on alternative media vs NA	0.057
S. aureus vs *E. coli* on alternative media	0.040

Furthermore, *S. aureus* is also known to be able to utilize carbohydrates and amino acids. *S. aureus* uses the tricarboxylic acid cycle (TCA, also known as the citric acid cycle), pentose phosphate (PPP), and the Embden-Meyerhof-Parnas (EMP) pathway to catabolize carbohydrates (Ferreira et al., 2013). Through biochemical tests, it is proven that *S. aureus* is at least able to ferment glucose, lactose, sucrose, fructose, and mannitol (El-Hadedy & Abu El-Nour, 2012); and consumed the amino acids alanine, serine, and aspartate during growth under aerobic conditions in vitro (Zühlke et al., 2016).

In this study, we also found that the number of colonies that grew on alternative media was less than in NA, both by *S. aureus* and *E. coli*. This shows that peptone and yeast extract in NA are truly in the ideal and simpler composition. Conversely, the composition of nutrients in alternative media, although many types are in a larger and more complex form so that the growth of microorganisms requires more time to decompose these components into simpler forms that can be absorbed by cells and used for cell synthesis and energy (Juariah, 2021). The process that requires time to break down complex nutrients to be simpler is clearly seen by *S. aureus* where the number of colonies in alternative media is significantly different from the number of colonies in NA; whereas *E. coli* can be said to be more efficient because the difference is not significant. In addition, it should be noted that vitamins also have the effect of inhibiting bacterial growth, for example vitamin C (Hassuna et al., 2023; Razzaq & Askar, 2023) and vitamin E (Vergalito et al., 2020). This could also be the reason why the number of bacterial colonies on alternative media is less than on NA.

To prove whether the number of E. coli and S. aureus colonies had a significant difference, the Mann-Whitney U statistical test was used. The Mann-Whitney U test between the number of *S. aureus* colonies on alternative media and NA media obtained a significance value of 0.006 (p ≤ α 0.05), which means that there was a difference in the number of colonies in the two groups. Meanwhile, in the test between the number of *E. coli* colonies on alternative media and NA, a significance value of 0.057 (p > α 0.05) was obtained, which meant that there was no difference in the two groups. Next, between the number of *S. aureus* and *E. coli* colonies on the alternative media, a significance value of 0.040 (p ≤ α 0.05), was obtained, which means that there was a difference in the number of colonies in the two groups (Table 3).

4. CONCLUSION

This study shows that Cilembu sweet potatoes contain the nutrients needed by S. aureus and E. coli, as evidenced by the presence of colonies that grow with characteristics similar to NA. However, because the nutrients in it must be decomposed into a simpler form, we remind that the use of alternative media is more intended for simple Gram-negative bacteria such as E. coli, rather than Gram-positive like S. aureus. Further research is needed by combining Cilembu sweet potato flour with other nutritional sources that can better support the growth of S. aureus.

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R E S E A R C H **Open Access**

Development of an Early Detection Tool for Pneumonia in Toddlers with Ari Program Respiratory Rate Timer Based on the Internet of Things

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Abstract
Delays in establishing a diagnosis of pneumonia in toddlers can increase toddler morbidity and mortality. Early pneumonia detection tools are very necessary to be able to provide appropriate intervention. The objective is to develop an early-detection tool for pneumonia in toddlers using the ARI Programme Respiratory Rate Time based on the Internet of Things by calculating respiratory frequency and oxygen saturation. The research methods use Research and Development (R&D) was carried out on toddlers with cough complaints in the working area of the Grogol Health Center, Sukoharjo Regency from December 2023 to January 2024. The sample consisted of 100 toddlers who were selected using consecutive sampling. The dependent variables are respiratory frequency and oxygen saturation. The independent variables are ARI based on IoT, ARI Timer, and pulse oximeter. Other data is collected through observation sheets. Data were analyzed using independent t-test analysis using the SPSS version 26. The results of the validation test assessment by 6 experts obtained a total average score of 95.48% with very valid assessment criteria, which means the tool is suitable for use. The results of the Independent T-Test show that there is no difference between IoT-based ARI (Mean=39.28; SD=9.05) and Timer ARI (Mean±SD= 39.29±9.07), this result is not statistically significant (p=0.994) and does not exist. the difference between IoT-based ARI (Mean±SD= 94.90±2.55) and pulse oximeter (Mean±SD= 95.15±2.61), this result is not statistically significant (p=0.494). The conclusion is an ARI Programme Respiratory Rate Timer based on the Internet of Things tool can be developed for the early detection of pneumonia in toddlers and is suitable for use to determine the respiratory frequency and oxygen saturation in toddlers.

Keywords: Pneumonia, ARI based on IoT, Respiratory Frequency, Oxygen Saturation.

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1. INTRODUCTION

Acute Respiratory Infection (ARI), especially pneumonia, remains a major disease that is the main cause of morbidity and death in children (Kurniawan, Sutiningsih, & Martini, 2023). Pneumonia causes more than 5 million deaths each year in children under five in developing countries. The World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) have warned that every 39 seconds, one child dies from pneumonia (Sudrajat, 2020). Typical symptoms of this disease include increased respiratory frequency and difficulty breathing due to sudden lung inflammation. Pneumonia is an inflammatory process in the alveoli of the lungs caused by microorganisms such as *Streptococcus aureus*, *Streptococcus pneumoniae*, *Escherichia coli*, *Haemophilus influenzae*, and *Pneumocystis jiroveci* (Sa'diyah et al., 2022). Pneumonia is an endemic disease that spreads in almost all developing countries and is a very important problem (Fatimah F, 2022).

The incidence of pneumonia cases in developing countries, such as Indonesia, reaches around 30% in children under five years of age, which is equivalent to 10-20 cases per 100 children per year, and this is accompanied by a significant mortality rate (Winarsih, Ikrawati, & Handayani, 2023). In 2018, estimates show that around 19,000 children died from pneumonia. The Ministry of Health of the Republic of Indonesia recorded in 2021 that as many as 5,386 (19.13%) toddlers died between the ages of 29 days to 11 months (post-neonatal), 2,506 (8.9%) toddlers died between the ages of 12 to 59 months, and pneumonia is the main cause of post-neonatal under-five deaths, reaching 14.5%. The Central Statistics Agency (BPS) reported that 42.83% of deaths under five in the age range 12-59 months were caused by parasitic infections, while pneumonia caused 5.05% of deaths, diarrhea 4.5%, drowning 0.05%, and other factors 47.41% (Hakim, & Febriana, 2023).

Central Java Province is in third place in terms of the highest number of pneumonia cases among children under five in Indonesia in the period 2013 to 2017 (Sari & Cahyati 2019; Sari & Ridza, 2021). In 2021, Central Java Province reported that 31% of under-five deaths were caused by pneumonia (Dinas Kesehatan Provinsi Jawa Tengah, 2022). In 2019, Sukoharjo Regency reported 22 deaths of children under five, of which 1 case was caused by pneumonia (Pemerintahan Kabupaten Sukoharjo, 2022). Pneumonia is the second most common disease suffered by toddlers after diarrhea in Sukoharjo Regency. In 2019, the prevalence of pneumonia cases reached 3.61%, or around 1,315 cases. In 2018, 991 cases were reported, in 2017 around 993 cases, and in 2016 around 556 cases. These data indicate that there was an increase in the number of cases reported in 2019 compared to previous years (Dinas Kesehatan Kabupaten Sukoharjo, 2020). Grogol Health Center, Sukoharjo Regency is one of the health centers that has a high average number of visits from sick toddlers, reaching 148 sick toddlers per month.

One of the strategies used in managing pneumonia cases is to apply the Integrated Management of Sick Toddlers (MTBS) approach through the Acute Respiratory Tract Infection Prevention and Control Program (P2P ISPA) (Siregar & Nugraha, 2020). Implementation of the IMCI strategy has helped accelerate the reduction in mortality due to respiratory diseases and also increased the benefits obtained through ISPA control strategies (Aryani, 2017). In the implementation of P2P ISPA, medical devices such as the ARI Sound Timer and Pulse Oximeter are needed to assist in early detection and diagnosis of pneumonia (Harahap, Priyatna, Figna, & Rambe, 2023).

The ARI Sound Timer can be used to detect abnormal respiratory symptoms in toddlers, while the pulse oximeter helps in measuring blood oxygen levels, which is important for assessing the severity of respiratory illnesses. ARI Sound Timer is the currently recommended method for measuring respiratory frequency by counting the number of breaths in one minute (Karlen et al., 2014). Pulse oximeter is a safe and precise non-invasive method for measuring the level of oxygen contained in the blood. This tool is indispensable for

measuring oxygen saturation in arterial hemoglobin and can help in detecting hypoxic conditions at an early stage, before they reach potentially fatal levels, and allows immediate assistance (Naufal & Rifa'i, 2021).

One of the main problems faced by the ISPA P2P program is early detection and management of pneumonia cases. The implementation of the IMCI approach in community health centers is still not optimal, and the capacity of staff to diagnose pneumonia is still low. The low level of commitment of community health center staff in carrying out respiratory frequency calculations and lower chest wall retraction (TDDK) examinations is also an obstacle. In addition, limited resources, such as program oumonperational funds and tools for early detection, are obstacles to implementing the program, especially at community health centers (Kementerian Kesehatan RI, 2022).

The ARI Respiratory Rate Timer Program Based on the Internet of Things can be connected to laptops and smartphones because it is connected to the internet network. The examination results database is stored in cloud software, making it easier for health workers to access it. In addition, the stored database can be directly printed as reporting data or research data to help determine policies related to the problem of treating pneumonia. The large benefits that can be felt from using this tool, made the author take up research entitled development of an early detection tool for pneumonia in toddlers with the ARI Program respiratory rate timer based on the Internet of things.

2. RESEARCH METHOD

This research design study uses the Research and Development (R&D) method because this research design will produce certain products. Researchers will develop an early detection tool for pneumonia in toddlers using Internet of Things technology, where this tool will measure respiratory frequency and oxygen saturation as a basis for diagnosing pneumonia. The sampling technique used in this research is non-probability sampling with a consecutive sampling technique.

The population used in this study were toddlers with cough complaints who visited the KIA Room at the Grogol Health Center, Sukoharjo Regency. The number of visits by sick toddlers during the January-September 2023 period reached 1,331 patients with an average monthly visit of 148 babies under five.

The sample in this study was 100 toddlers with cough complaints who visited the KIA Room at the Grogol Health Center, Sukoharjo Regency who met the inclusion and exclusion criteria. The independent variable in this research is the Early Detection Tool for Pneumonia in Toddlers with the ISPA Respiratory Rate Timer Program Based on the Internet of Things. The variables related to this research are Early Detection of Pneumonia in Toddlers Based on Respiratory Frequency and Oxygen Saturation. The sampling technique used in this research is non-probability sampling with consecutive sampling techniques.

Data collection techniques use primary data and secondary data. Primary data is data obtained directly from a respondent who is the research subject, which in this case is data on toddlers who have coughs, toddler age, number of breaths, and oxygen saturation. Secondary data for this research is data related to toddlers who have coughs at the Grogol Health Center, Sukoharjo Regency which is used in this research, such as information regarding birth weight.

This research instrument uses the ARI Program Respiratory Rate Timer based on the Internet of Things and respondent identity sheets. The ARI Program Respiratory Rate Timer based on the Internet of Things is a tool development that is used as an early detection tool for pneumonia in toddlers. This tool has the function of measuring a toddler's respiratory frequency for 60 seconds or one minute and measuring oxygen saturation to assess the

toddler's condition so that a diagnosis can be made according to the classification in the guidelines for integrated management of sick toddlers (MTBS).

The data analysis method uses univariate and bivariate analysis. Bivariate analysis was collected in the form of a frequency distribution table and mean ± standard deviation (SD). Next, the research results will be discussed using relevant theories and references. Bivariate statistical analysis that will be used is the independent t-test to test differences in mean respiratory frequency and oxygen saturation using different measuring instruments. The confidence level used is 95% with an alpha of 5%. This research has been carried out for ethical feasibility under number 1324/EA/KEPK/2023.

3. RESULTS AND DISCUSSION

Table 1. Characteristics of respondents in large-scale trials of the ARI program respiratory rate timer tool based on the Internet of Things.

Characteristics	Category	Frequency	Percentage
Parents' Age	<20 years	2	2,0
	20-35 years	82	82,0
	>35 years	16	16,0
Total		100	100
Education	Elementary School	2	2,0
	Junior High School	27	27,0
	Senior High School	62	62,0
	College	9	9,0
Total		100	100
Child's Gender	Male	55	55,0
	Female	45	45,0
Total		100	100
Child's Age	>12-24 months	25	25,0
	>24-36 months	23	23,0
	>36-48 months	26	26,0
	>48-59 months	26	26,0
Total		100	100

Table 1 displays the frequency distribution of respondents' characteristics in terms of parental age, namely the majority are in the 20 to 35-year age range, 82 people (82%). The majority of parents' last level of education was up to Senior High School (SMA) level, 62 people (62%). The characteristics of the children in terms of gender show that the majority are male, 55 children (55%), while the age of the children shows that the majority are aged between >36-48 months and >48-59 months, respectively 26 children (26%).

Data homogeneity and normality tests need to be carried out before carrying out a comparative analysis of the results of measurements of respiratory frequency and oxygen saturation in the control group using the ARI Timer and pulse oximeter, while the intervention group uses the ARI Program Respiratory Rate Timer based on the Internet of Things. The results of the data homogeneity test for the respiratory frequency variable in the control group and intervention group were p(0.994)>0.05, which means that the data is homogeneous. The results of the data homogeneity test for the oxygen saturation variable in the control group and intervention group were p(0.812)>0.05, which means that the data is homogeneous.

The results of the data normality test are p value> 0.05, which means that the data is normally distributed. The results of the data normality test in both groups show that the

sample standard deviation in each group is around the population standard deviation, which means it is normally distributed.

Table 2. A Comparison of the Use of the ARI Program Respiratory Rate Timer Tool Based on the Internet of Things with ARI Timer in Determining Respiratory Frequency.

Variable		Control	Intervention	p-*value*
Respiratory Frequency	Mean ± SD	39,29 ± 9,07	39,28 ± 9,05	0,994
	Min – Max	26,00 – 66,00	26,00 – 66,00	

Table 2 displays the results of data analysis on a large-scale trial of the Internet of Things-based ARI Program Respiratory Rate Timer tool using the Independent T-Test and obtained a p-value (0.994)>0.05. The p value> 0.05 means that the average measurement results on respiratory frequency in the control group (ARI Timer) and the intervention group (ARI Program Respiratory Rate Timer based on Internet of Things) show no significant difference. So the ARI Program Respiratory Rate Timer tool based on the Internet of Things can be used to measure respiratory frequency in children aged >12 months to less than 5 years.

Table 3. A comparison of the results of measuring oxygen saturation in the control group using a pulse oximeter and the intervention group using the ARI Program Respiratory Rate Timer based on the Internet of Things.

Variable		Control	Intervention	p-*value*
Oxygen Saturation	Mean ± SD	95,15 ± 2,61	94,90 ± 2,55	0,494
	Min - Max	88,00 – 99,00	89,00 – 99,00	

Table 3 displays the results of data analysis on a large-scale trial of the Internet of Things-Based ARI Program Respiratory Rate Timer tool using the Independent T-Test and obtained a p-value (0.494)>0.05. The p value> 0.05 means that the average measurement results on oxygen saturation in the control group (pulse oximeter) and the intervention group (ARI Program Respiratory Rate Timer Based on Internet of Things) show no significant difference. So the ARI Program Respiratory Rate Timer tool based on the Internet of Things can be used to measure oxygen saturation in children aged >12 months to less than 5 years.

Sensitivity and specificity analysis of respiratory frequency measurement using the Internet of Things-Based ARI Program respiratory rate timer compared to ARI timer

a. Recall (Sensitivity)
Recall is the ratio of true positive predictions compared to the total true positive data. The recall value can be seen in the following data calculations:

Table 4. Recall (Sensitivity)

Recall	**=**	**(TP) / (TP+FN)**
	=	43 / (43+1)
	=	43 / 44
	=	0,98
	=	98%

The results of calculating the recall value obtained a value of 98%, which means that the model or information system is accurate in identifying relevant items. This can indicate

that the model is very good at doing its job and can be relied on to identify relevant items very well.

b.   Specificity

Specificity is the correctness of negative predictions compared to all negative data. The specificity value can be seen in the following data calculations:

Table 5. Specificity

Specificity	=	(TN)/ (TN + FP)
	=	56 / (56+0)
	=	56 / 56
	=	1
	=	100%

The results of calculating the specificity value obtained a value of 100%, which means that the tool or method used did not have positive errors. Specificity is the ability of a tool or method to produce truly negative results.

Analysis of Sensitivity and Specificity of Oxygen Saturation Measurement Using ARI Program Respiratory Rate Timer Based on Internet of Things Compared to Pulse Oximeter.

a.   Recall (Sensitivity)

Recall is the ratio of true positive predictions compared to the total true positive data. The recall value can be seen in the following data calculations:

Table 6. Recall (Sensitivity)

Recall	=	(TP) / (TP+FN)
	=	16 / (16+0)
	=	16 / 16
	=	1
	=	100%

Table 6 The results of calculating the recall value obtained a value of 100%, which means that the model or information system is very accurate in identifying relevant items. This can indicate that the model is very good at doing its job and can be relied on to identify relevant items very well.

b.   Specificity

Specificity is the correctness of negative predictions compared to all negative data. The specificity value can be seen in the following data calculations:

Table 7. Specificity

Specificity	=	(TN)/ (TN + FP)
	=	84 / (84+0)
	=	84 / 84
	=	1
	=	100%

The results of calculating the specificity value obtained a value of 100%, which means that the tool or method used did not have positive errors. Specificity is the ability of a tool or method to produce truly negative results.

DISCUSSION

1.   Results of respiratory frequency measurement using the ARI program respiratory rate timer tool based on the Internet of Things

Pneumonia is an inflammatory condition of the lungs in which the air sinuses in the lungs fill with inflammatory fluid, and can involve the infiltration of inflammatory cells into the walls of the alveoli and the spaces between the lung tissue. Pneumonia is often an acute bacterial infection and is characterized by a sudden attack, symptoms of fever, chills, pain in the pleura area, difficulty breathing (*dyspnea*), rapid breathing (*tachypnea*), productive cough with red phlegm, and an increase in the number of white blood cells (*leukocytosis*) (Prabawa, 2016).

This research tests a tool that has been designed to measure respiratory frequency in toddlers, namely the ARI Program Respiratory Rate Timer based on the Internet of Things. This tool uses an FSR sensor which is installed on the belt and functions to receive the pressure generated by breathing activity so that the respiratory frequency can be calculated. The test results of the ARI Program Respiratory Rate Timer tool based on the Internet of Things in measuring respiratory frequency showed that the measurement error value was less than 5%, namely 1.04% and the accuracy value reached 98.96%, meaning that the calibration value of the sensor sensitivity used in the tool was valid. used.

Based on data analysis from a comparison of measurement results using old and new equipment, the results show that the average measurement results on respiratory frequency in the control group (ARI Timer) and the intervention group (ARI Program Respiratory Rate Timer based on Internet of Things) show no significant difference. So the ARI Program Respiratory Rate Timer tool based on the Internet of Things can be used to measure respiratory frequency in children aged >12 months to less than 5 years.

The ARI Program Respiratory Rate Timer based on the Internet of Things has several advantages compared to previous tools, namely that the respiratory frequency calculation is carried out automatically by this tool. Previously, respiratory frequency calculations were done manually by looking at the movement or rise and fall of the toddler's stomach and assisted by the ARI Timer tool as a reminder of the time. Manual calculations are carried out for 60 seconds by officers, but in practice, officers only count for 30 seconds and then the results are multiplied by 2 to get a count of 60 seconds. This can increase the risk of errors or discrepancies in respiratory frequency calculation results. Errors in calculating respiratory frequency can result in incorrect diagnosis of pneumonia in toddlers resulting in inappropriate treatment of the disease.

The results of calculating respiratory frequency using the Internet of Things-based ARI Program Respiratory Rate Timer will appear automatically on the device's LCD screen. The results will be visible immediately without the need to calculate manually. Another advantage of this tool is that it is able to store examination result data in a database which can be accessed directly anytime and anywhere using a device (laptop or smartphone) because it is connected to the internet network. Different from previous tools, manual calculation results must be recorded on the patient's physical examination sheet and the results can only be seen when looking at the patient's medical record document.

The results of this research are in line with research that designs tools based on the Internet of Things so that the tools created can be connected to the internet. The use of Internet of Things-based technology will make it easier for users to access electronic equipment online via an internet connection using a smartphone. Users can do this whenever and wherever they want as long as the device is connected to the internet network. This

device can be accessed with internet services via an Android smartphone so that it can increase the level of energy efficiency and working hours. This Internet of Things-based technology is appropriate to apply because it makes it easier for officers to carry out this work (Efendi, 2018).

Another study designed a tool used to calculate respiratory frequency in toddlers using an application embedded in an Android smartphone. The advantages of this tool are the same as those of the ARI Program Respiratory Rate Timer based on the Internet of Things. This tool can be accessed directly using a smartphone and is able to display measurement results that are more valid than the results of manually calculating respiratory frequency using ARI Timer. Calculation of respiratory frequency has many risks of error, such as the officer forgetting to calculate the sequence of numbers because it was done for 60 seconds or the officer only calculating the respiratory frequency for 30 seconds and then multiplying it by 2 to get the respiratory frequency result for 60 seconds (Karlen W, Gan H, 2014).

The results of research that has been carried out and compared with previous research proves that the ARI Program Respiratory Rate Timer based on the Internet of Things can be used to measure respiratory frequency in children aged >12 months to less than 5 years with an error percentage of 1.04% and an accuracy percentage value. 98.96%. These results make this tool accurate enough to be used to measure respiratory frequency in toddlers. Testing a tool with a percentage error value of no more than 5% indicates that the calibration value of the sensitivity of the sensor used on the tool is valid to use.

Detection is generally carried out by identifying signs of abnormality or abnormality in a disease. This approach aims to prevent more serious complications that can harm a person's personality. This step can help individuals develop healthy thoughts, feelings and behavior, so that their existence can be accepted and recognized in the social environment as an overall healthy individual (Setyoningrum & Mustiko, 2020). Early detection also plays a role as a preventive measure from an early stage against possible indications of disorders (Wijayanti, Purwaningsih, & Trimawati, 2019).

2. **Results of measuring oxygen saturation using the ARI program respiratory rate timer tool based on the Internet of Things**

This research tests a tool that has been designed to measure oxygen saturation in toddlers, namely the ARI Program Respiratory Rate Timer based on the Internet of Things. This tool uses a MAX30100 sensor which is used to measure oxygen saturation. The test results of the ARI Program Respiratory Rate Timer tool based on the Internet of Things in measuring oxygen saturation showed that the measurement error value was less than 5%, namely 0.89, and the accuracy value reached 99.11%, meaning that the calibration value of the sensor sensitivity used in the tool was valid. used.

Pneumonia is an acute respiratory infection that affects lung tissue, especially the alveoli, and is usually characterized by symptoms such as coughing and difficulty breathing (Afriani & Oktavia, 2021). Pneumonia is a public health problem because it is one of the factors causing the high infant mortality rate in Indonesia (Riyanto & Megasari, 2021). Toddlers who experience pneumonia and do not immediately receive appropriate treatment are at risk of death. Pneumonia is an inflammatory condition of the lung tissue, which in children is often described as bronchopneumonia (Siregar, 2018). Symptoms of pneumonia are often characterized by indrawing of the chest wall, rough breathing sounds when the child takes a breath (stridor), and rapid breathing (Lutfah & Heryawan, 2017).

Based on data analysis from the comparison of measurement results using old and new equipment, the results show that the average measurement results on oxygen saturation in the control group (pulse oximeter) and the intervention group (ARI Program Respiratory Rate Timer based on Internet of Things) show no significant difference. So the ARI Program

Respiratory Rate Timer tool based on the Internet of Things can be used to measure oxygen saturation in children aged >12 months to less than 5 years.

The ARI Program Respiratory Rate Timer based on the Internet of Things has several advantages compared to previous tools, namely that the oxygen saturation calculation is carried out simultaneously with the calculation of the toddler's respiratory frequency so that the diagnosis of pneumonia in toddlers is made faster. Pneumonia can be detected as early as possible with this tool so that toddlers can get more appropriate and faster treatment before the toddler's condition gets worse. Accuracy and speed in establishing a diagnosis of pneumonia can help reduce the risk of morbidity and mortality in toddlers due to pneumonia. Previously, oxygen saturation calculations could only be done at referral sites. When an examination is carried out at the first health service facility such as a Community Health Center, health workers can only calculate the respiratory frequency of toddlers manually using the available tool, namely the ARI Timer. If the calculation results show that the toddler is experiencing rapid breathing (more than 40 times per minute for ages >12 months to less than 5 years), then they will be referred to the hospital for an oxygen saturation check to determine the classification of pneumonia the child is suffering from. This will take a long time because many procedures must be completed, which can increase the risk of morbidity and mortality due to pneumonia due to delays in treating the disease.

The results of oxygen saturation calculations using the Internet of Things-based ARI Program Respiratory Rate Timer will appear automatically on the device's LCD screen. The results will be visible immediately so that you can immediately make a diagnosis of pneumonia according to the predetermined classification. Another advantage of this tool is that it is able to store examination result data in a database which can be accessed directly anytime and anywhere using a device (laptop or smartphone) because it is connected to the internet network. Different from previous tools, the calculation results only appear on the monitor screen and must be recorded on the patient's physical examination sheet so that the results can only be seen when viewing the patient's medical record documents.

The results of this research are in line with research that designs tools based on the Internet of Things so that the tools created can be connected to the internet. The use of Internet of Things-based technology will make it easier for users to access electronic equipment online via an internet connection using a smartphone. Users can do this whenever and wherever they want as long as the device is connected to the internet network. This device can be accessed with internet services via an Android smartphone so that it can increase the level of energy efficiency and working hours. This Internet of Things-based technology is appropriate to apply because it makes it easier for officers to carry out this work (Efendi, 2018).

Another study designed a tool used to calculate oxygen saturation using an application embedded in an Android smartphone. The advantages of this tool are the same as those of the ARI Program Respiratory Rate Timer based on the Internet of Things. This tool can be accessed directly using a smartphone and is capable of displaying valid measurement results. The pulse oximeter embedded in the application on the smartphone has high accuracy when compared to modern pulse oximeters and is very helpful in measuring oxygen saturation because it is easy to access anywhere and at any time (Nufal F, 2021).

The results of research that has been carried out and compared with previous research prove that the ARI Program Respiratory Rate Timer based on the Internet of Things can be used to measure oxygen saturation in children aged >12 months to less than 5 years.

3. **Results of sensitivity and specificity analysis of respiratory frequency measurement using the ARI program respiratory rate timer based on the Internet of Things**

Measuring respiratory frequency using the ARI Program Respiratory Rate Timer based on the Internet of Things has an accuracy value of up to 99%, which means that the tool has classification capabilities with a good level of accuracy. The results of calculating the precision value obtained a value of 100%, which means that the tool has a high level of accuracy in making measurements. This means that the measurement results obtained from this tool have no difference compared to previously determined reference or standard values.

The results of calculating the sensitivity value obtained a value of 98%, which means that the model or information system is accurate in identifying relevant items. This can indicate that the model is very good at doing its job and can be relied on to identify relevant items very well. The results of calculating the specificity value obtained a value of 100%, which means that the tool or method used did not have positive errors. Specificity is the ability of a tool or method to produce truly negative results. The results of calculating the F1 Score value obtained a value of 99%, which means that the model has very good performance in classifying the data. Based on a scale of 0-1, the F1 Score value of 0.99 indicates that the model is able to achieve high accuracy and is able to balance precision and recall well.

4. **Results of sensitivity and specificity analysis of oxygen saturation measurements using the ARI program respiratory rate timer based on the Internet of Things**

Measuring oxygen saturation using the ARI Program Respiratory Rate Timer based on the Internet of Things has an accuracy value of 100%, which means that the tool has classification capabilities with a good level of accuracy. The results of calculating the precision value obtained a value of 100%, which means that the tool has a high level of accuracy in making measurements. This means that the measurement results obtained from this tool have no difference compared to previously determined reference or standard values. The results of calculating the sensitivity value obtained a value of 100%, which means that the model or information system is very accurate in identifying relevant items. This can indicate that the model is very good at doing its job and can be relied on to identify relevant items very well.

The IoT concept is applied where all machines are given an identifier in the form of an IP address and use the internet network as a communication medium to exchange data between each other. This allows machines to interact in various locations without the constraints of distance (Kumar, Tiwari, & Zymbler, 2019). Sistem ini didesain dengan menggunakan algoritma cerdas yang dapat membantu dalam memprediksi dan mendiagnosis kondisi pasien berdasarkan gejala dan informasi medis (Handoko, & Neneng, 2021).

Pneumonia is inflammation of the lungs caused by infection from various types of microorganisms. Symptoms of pneumonia include fever, chills, night sweats, chest pain, cough, shortness of breath, phlegm, and headache. These symptoms are similar to those of other respiratory illnesses, making an accurate diagnosis time-consuming and expensive (Abdjul & Herlina, 2020). As a result, doctors often have to perform several tests before making a diagnosis. To ensure patients suffering from pneumonia receive appropriate care and treatment, it is vital to have access to the ongoing expertise and knowledge of specialist physicians (Arani et al, 2019).

The results of calculating the specificity value obtained a value of 100%, which means that the tool or method used did not have positive errors. Specificity is the ability of a tool or method to produce truly negative results. The results of calculating the F1 Score value obtained a value of 100%, which means that the model has very good performance in

classifying the data. Based on a scale of 0-1, an F1 Score value of 1 indicates that the model can achieve high accuracy and can balance precision and recall well.

This research has achieved significant progress in developing an expert system for early detection of pneumonia, with a high level of accuracy in identifying pneumonia cases. This research underscores the potential of such systems in the healthcare sector, while highlighting the importance of continuously improving their performance. In addition to increasing medical knowledge, this research also has the potential to improve health care outcomes for the general public (Cahyanto, Zulkarnain, & Farida, 2023).

IoT is a concept that aims to utilize internet connectivity that remains continuously connected. This allows us to connect various machines, equipment, and other physical objects with networked sensors and actuators. In this way, we can collect data and control the performance of these devices automatically. The tool developed is capable of storing measurement results data, including patient identity and examination results data as a data source for reporting pneumonia cases (Ranjan, Rao, Kumar, & Sharma, 2023).

4. CONCLUSION

The conclusion of the research regarding the development of an early detection tool for pneumonia in toddlers with the ARI Program Respiratory Rate Timer based on the Internet of Things, namely the ARI Program Respiratory Rate Timer tool based on the Internet of Things can be developed for early detection of pneumonia in toddlers based on the results of calculating respiratory frequency and oxygen saturation. This tool is suitable for use to determine respiratory frequency and oxygen saturation in toddlers with a validation value of 95.48%. This tool is valid for determining respiratory frequency with an accuracy percentage value of 98.96% and valid for determining oxygen saturation with an accuracy percentage value of 99.11%. So, the ARI Program Respiratory Rate Timer tool based on the Internet of Things has a sensitivity level of 98% and specificity of 100% for measuring respiratory frequency and has a level of sensitivity of 100% and specificity of 100% for measuring oxygen saturation.

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R E S E A R C H　　　　　　　　　　　　　　　**Open Access**

Does siPantau Bumil GIS-Based Able to Increase K6 Visits and Reduce Complication for High-Risk Pregnant Women?

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Abstract
K6 visits and obstetric complications scope is one indicator of maternal health program services. Scarcely have these indicator's achievements met the expected targets so innovation is needed to improve them. The method that can be used to increase the accomplishment is digitalization, through the use of applications to provide and improve the health services quality in monitoring pregnant women. The objective is to design and investigate the GIS (Geographical Information System) influence on pregnancy monitoring practice, especially on K6 visits and pregnant women's high-risk obstetric complications in Pekalongan City. This research uses the Research and Development (R&D) method with a quasi-experimental research design and posttest control group design. The population is pregnant women with high-risk factors at 32 weeks gestation in Pekalongan City. The total sample is 60 people, who were divided into two groups, namely 30 respondents in the intervention group and 30 respondents in the control group. In the intervention group, pregnant women were given monitoring through the Sipantau Bumil application and K6 visit notifications, while in the control group, the K6 visit schedule was written in the KIA book. Moreover, the data analysis used the Chi-Square test. The result is the siPantau Bumil application has increased K6 visits with a significance value of p-value=0.012 (p<0.005). In addition, it also reduces obstetric complications with a significance value of p-value=0.002 (p<0.005). The conclusion is the GIS-based pregnancy monitoring application can increase K6 visits and reduce obstetric complications.

Keywords: Sipantau Bumil Application, K6 Visit, Obstetric Complication.

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1.   INTRODUCTION

The maternal mortality rate (MMR) in Indonesia is still relatively high. Until now, the MMR is still in the range of 305 per 100 thousand babies born alive, while the SDGs target that must be achieved by 2024 is 183 per 100 thousand babies born alive . The number of cases of maternal death recorded in the performance records of the Ministry of Health's Family Health Program shows that cases of maternal death are increasing every year. In 2020 the number of reported cases was 4,627 cases, while in 2021 the number of reported cases increased to 7,389 cases (Kementerian Kesehatan RI, 2022).

Maternal mortality in Central Java shows the same trend as maternal mortality in Indonesia. In 2019 the MMR was 76.9 per 100 thousand babies born alive, in 2020 it rose to 98.6 per 100 thousand babies born alive (Dinas Kesehatan Provinsi Jawa Tengah, 2022). In 2021, the MMR in Central Java will reach 199 per 100 thousand babies born alive (Dinas Kesehatan Provinsi Jawa Tengah, 2022) Maternal death cases in Pekalongan City have also increased since 2019 by 6 cases, then rose to 9 cases in 2020 and 11 cases in 2021 (Dinas Kesehatan Kota Pekalongan Tahun 2020)

The incidence of death that befalls a mother can be caused by risk factors experienced by the mother from the time of pregnancy to delivery, such as the 4 "too" criteria, namely too young the mother's age when pregnant/giving birth (mother's age < 20 years), too old the mother's age at the time of birth. pregnancy/giving birth (mother's age > 35 years), too many children (> 4 children born), and too close birth spacing (pregnancy interval < 2 years).

Maternal health service coverage as described in Q1 2019 to 2021 in Central Java tends to increase. However, there was a decrease in K4 achievements in 2020 compared to 2019, namely from 94.7 percent to 94.1 percent (Dinas Kesehatan Provinsi Jawa Tengah, 2022). K1 coverage from 2019 to 2022 in Pekalongan City has reached 100%, while K4 coverage from 2019 to 2021 respectively is 97.7%, 98.2% has decreased in 2021 to 95.9% and in 2022 to 97.5% (Dinas Kesehatan Kota Pekalongan, 2021).

K6 coverage will start from 2021 with a national target that must be achieved, namely 80%. The K6 coverage achievement for Central Java province in 2021 is 72% and in 2022 it is 82.94 (Dinas Kesehatan Provinsi Jawa Tengah, 2022). K6 coverage in Pekalongan City in 2021 is 77.5%, while in 2022 it will be 77.7%. This shows that K6 coverage in Pekalongan City is still below the set target (Dinas Kesehatan Kota Pekalongan, 2021).

In Pekalongan City, the coverage for handling obstetric complications is still relatively high every year, in 2019 it was 117.2%, in 2020 it was 118.6%, in 2021 it was 119% and in 2022 it increased sharply to 146.4%. This increase in the number of coverage for obstetric complications shows that there is an increase in cases of obstetric complications from the estimated target (Dinas Kesehatan Kota Pekalongan, 2021).

It is predicted that around 74% of deaths that befall a mother can be prevented, if the quality of health services provided to the mother is superior and adequate in determining early diagnosis of obstetric complications or high risks and there is easy affordability of obtaining health services (Farhati, Sekarwana, & Husin, 2018). Obstetric complications must be handled/treated appropriately in order to reduce the death rate in pregnant, giving birth or postpartum women (Kementerian Kesehatan RI, 2020).

The use of applications for early detection of pregnancy risks (DDILAN) has been researched to increase pregnant women's knowledge and attitudes about pregnancy risks (Ismayanty et al., 2019). The Wellingbom 2.0 application has been proven to increase the husband's ability to detect high-risk pregnancies early (Pratamaningtyas & Titisari, 2022). The use of the M-Health application has been proven to increase knowledge, attitudes, and behavior to prevent dangerous signs of pregnancy in pregnant women, and can reduce complaints of nausea and vomiting in pregnant women (Puspitasari, 2019).

From this description, it was found that there was a gap in achievement data between K1-K4 and K6 coverage. The difference in achievement between K1 and K4 coverage in 2022 is 2.5%, while the difference in achievement between K1 and K6 coverage in 2022 is 22.3%. The achievement gap between K1-K4 and K6 coverage indicates a discontinuity in visits between K1-K4 and K6. Thus, it can be interpreted that if there is no gap between K1-K4 and K6, then all pregnant women have made their first visit to receive a pregnancy check-up and continue until the sixth visit in the 3rd trimester, pregnant women have been monitored regularly by health workers.

The pregnant woman's application designed by Suparni (2021) in Pekalongan City illustrates the effectiveness of using the application on maternal knowledge in detecting pregnancy risks. Of the several applications that have been designed, researched and implemented for pregnant women, they are still screening and providing education (Fatkhudin, & Zuhana, 2021). Therefore, researchers are interested in conducting research by creating the "SIPantau Bumil Based GIS" application which can provide information on the location of pregnant women, types of risks for pregnant women, K6 visit schedules for pregnant women, types of obstetric complications, education and care that can be given to pregnant women so that makes it easier for midwives to monitor pregnant women, which will increase the coverage of K6 visits and reduce obstetric complications. The access for users of the siPantau Bumil application consists of pregnant women, midwives/Puskesmas, and health services. The health service as the health service regulator is involved as a user in using this application so that it can quickly find out the whereabouts of pregnant women and the types of risk factors in areas throughout Pekalongan City and evaluate the performance of community health centers in monitoring pregnant women.

2.   RESEARCH METHOD

This research uses Research and Development (R&D) methods to increase active monitoring for high-risk pregnant women and efforts to reduce the risk of obstetric complications. In the application developed, there is a visit reminder feature, birth interpretation as well as providing information and education through narrative descriptions and images.

Research procedures in the R&D category consist of five procedures to produce final products so they are ready to be applied in providing health services. The stages used are the adoption of a modified Borg and Gall model (Sugiyono, 2022). This research was carried out in Pekalongan City in 2023.

The population in this study were pregnant women with high-risk factors with a gestational age of 32 weeks residing in Pekalongan City. The population in this study was 60 people. The sample size in this study was calculated using the Lemeshow formula, resulting in a sample size of 60 respondents divided into a treatment group of 30 respondents and a control group of 30 respondents.

The independent variable in this research is the GIS-based siBumil application. Dependent variables were K6 visits and obstetric complications. Confounding variables in this study are age, education, employment, income, attitude, and husband's support.

3. RESULTS AND DISCUSSION

Table 1. Characteristics of Respondents

Characteristics Respondent	Intervention		Control		Total	
	n	**%**	**N**	**%**	**n**	**%**
Age						
Risk	9	30,0	12	40,0	21	35,0
No Risk	21	70,0	18	60,0	39	65,0
Education						
Basic	15	50,0	14	46,7	29	48,3
Middle	11	36,7	9	30,0	20	33,3
College	4	13,3	7	23,3	11	18,3
Work						
Housewife	17	56,7	20	66,7	37	61,7
Work	13	43,3	10	33,3	23	38,3
Income						
< UMK	8	26,7	14	46,7	22	36,7
≥UMK	22	73,3	16	53,3	38	63,3
Husband's support						
Doesn't support	10	33,3	9	30,0	19	31,7
Support	20	66,7	21	70,3	41	68,3
Mother's attitude						
Don't agree	6	20,0	14	46,7	20	33,3
Agree	24	80,0	16	53,3	40	66,7

Table 1 the age of respondents in the intervention group was in the no-risk category, namely 21 people (70%), in the control group the mother's age was mostly in the no-risk category, the number was 18 (60%). Overall, 39 (65%) respondents fell into the no-risk age category. The education level of respondents in the intervention group included 15 people (50%), in the control group the number of respondents with basic education was 14 (46.7%). Overall, 29 respondents fell into the basic education category (48.3%).

The work showed that the majority of respondents in the intervention group were in the IRT category. The number was 17 people (56.7%). In the control group, 20 respondents fell into the IRT category (66.7%). Overall, 37 respondents fell into the IRT category (61.7%). Income shows that the majority of respondents in the intervention group fall into the income category >= UMK. The number was 22 people (73.3%). In the control group, 16 respondents (53.3%) were in the income category >= UMK. Overall, 38 respondents fell into the income category >= UMK (63.3%).

Table 2. Overview of K6 Visits and Obstetric Complications

Description	Intervention		Control		Total	
	n	**%**	**n**	**%**	**n**	**%**
K6 Visits						
Not K6 Visits	5	16,7	14	46,7	19	31,7
K6 Visits	25	83,3	16	53,3	41	68,3
Obstetric Complications						
Complications	4	13,3	12	40,0	16	26,7
No complications	26	86,7	18	60,0	44	73,3

Table 2 shows that the majority of respondents made K6 visits. The number of respondents in the intervention group who made K6 visits was 25 respondents (83.3%). In the control group, the number of respondents who made K6 visits was 16 people (53.3%). Overall, 41 respondents (68.3%) visited both the intervention and control groups.

Most respondents did not experience obstetric complications. In the intervention group, 26 respondents (86.7%) did not experience obstetric complications. In the control group, 18 respondents (60%) did not experience obstetric complications. Overall, neither the intervention nor the control group experienced obstetric complications, as many as 44 people (73.3%).

Table 3. Influence of Respondent Characteristics on K6 Visits

| Characteristics Respondent | K6 Visits | | | | | | p- Value |
| | No K6 Visits | | K6 Visits | | Total | | |
	n	%	n	%	n	%	
Age							
Risk	9	42.9	12	57.1	21	100	0.172
No Risk	10	25.6	29	74.4	39	100	
Education							
Basic	13	44.8	16	55.2	29	100	
Middle	3	15	17	85	20	100	0,083
College	3	27.3	8	72.7	11	100	
Work							
Housewife	9	24.3	28	75.7	37	100	0.121
Work	10	14.6	13	85.4	23	100	
Income							
< UMK	12	54.5	10	45.5	22	100	0,004
≥ UMK	7	18.4	31	81.6	38	100	
Husbund's Support							
Doesm't support	13	68.4	6	31.6	19	100	0.000
Support	6	31.6	35	77.5	41	100	
Mother's Attitude							
Don't Agree	10	50	10	50	20	100	0.031
Agree	9	22.5	31	77.5	10	100	

Table 3 Effect of age on K6 visits the p-value of the chi-square test shows a figure of 0.172. Because the p-value is more than 0.05 (0.172>0.05), it can be concluded that age does not affect K6 visits. The effect of education on K6 visits the p-value of the chi square test shows a figure of 0.083. Because the p-value is more than 0.05 (0.083>0.05), it can be concluded that education has no effect on K6 visits. The effect of work on K6 visits the p-value of the chi-square test shows a figure of 0.121. Because the p-value is more than 0.05 (0.121>0.05), it can be concluded that work has no effect on K6 visits.

The effect of income on K6 visits the p-value of the chi-square test shows a figure of 0.004. Because the p-value is less than 0.05 (0.004<0.05), it can be concluded that income has an effect on K6 visits. The effect of the husband's support on K6 visits the p-value of the chi-square test shows a figure of 0.000. Because the p-value is less than 0.05 (0.000<0.05), it can be concluded that the husband's support influences K6 visits. Influence of the mother's attitude towards k6 visits the p-value of the chi-square test shows a figure of 0.031. Because the p-value is less than 0.05 (0.031<0.05), it can be concluded that attitude influences K6 visits.

Table 4. Influence of Characteristics on Obstetric Complications

	Obstetric Complications						p-value
	Complications		No Complications		Total		
	N	%	N	%	n	%	
Age							
Risk	9	42.9	12	57.1	21	100	0.037
No Risk	7	17.9	32	82.1	39	100	
Education							
Basic	11	37.9	18	62.1	29	100	
Middle	3	15	17	85	20	100	09.1
College	2	18.2	9	81.8	11	100	
Work							
Housewife	7	18.9	30	81.1	37	100	0.085
Work	9	39.1	14	60.9	23	100	
Income							
< UMK	12	54.5	10	45.5	22	100	0.004
≥ UMK	4	18.4	34	81.6	38	100	
Husband's Support							
Doesn't Support	13	64.4	6	31.6	19	100	0.000
Support	3	7.3	38	92.7	41	100	
Mother's Attitude							
Don't Agree	14	46.7	16	53.3	30	100	0.012
Agree	5	16.7	25	83.3	30	100	

Table 4 shows the effect of age on obstetric complications the p-value of the chi-square test shows a figure of 0.037. Because the p-value is less than 0.05 (0.037<0.05), it can be concluded that age affects obstetric complications. The effect of education on obstetric complications the p-value of the chi-square test shows a figure of 0.159. Because the p-value is more than 0.05 (0.159>0.05), it can be concluded that education has no effect on obstetric complications. The effect of work on obstetric complications The p-value of the chi-square test shows a figure of 0.085. Because the p-value is more than 0.05 (0.085>0.05), it can be concluded that work does not affect obstetric complications.

The effect of income on obstetric complications The p-value of the chi-square test shows a figure of 0.004. Because the p-value is less than 0.05 (0.004<0.05), it can be concluded that income affects obstetric complications. The effect of husband's support on obstetric complications. The p-value of the chi-square test shows a figure of 0.000. Because the p-value is less than 0.05 (0.000<0.05), it can be concluded that the husband's support affects obstetric complications. The effect of mother's attitude on obstetric complications The p-value of the chi-square test shows a figure of 0.000. Because the p-value is less than 0.05 (0.000<0.05) it can be concluded that attitude influences obstetric complications.

Table 5. Effect of the GIS-based siPantau Bumil application on K6 visits.

	K6 Visits						p-value
Group	No K6 Visits		K6 Visits		Total		
	n	%	n	%	n	%	
Control	14	46.7	16	53.3	30	100	0.012
Intervention	5	16.7	25	83.3	30	100	

Table 5 shows that the intervention group had more K6 visits compared to the control group. Of the 30 respondents in the intervention group, 25 respondents (83.3%) had K6 visits, while in the control group, only 16 respondents (53.3%) had K6 visits. 5 respondents in the intervention group did not make K6 visits (16.7%), while in the control group there were 14 people (46.7%). This shows that the intervention group had more K6 visits compared to the control group.

The p-value of the chi-square test shows a figure of 0.012. Because the p-value is less than 0.05 (0.012<0.05), it can be concluded that the GIS-based surveillance application for pregnant women affects K6 visits.

Table 6. Effect of the GIS-Based SiPantau Pregnancy Application on Obstetric Complications.

| Group | Obstetric Complications | | | | | | p-value |
| | No Complications | | Complications | | Total | | |
	n	%	n	%	n	%	
Control	18	60	12	40	30	100	0.020
Intervension	26	86.7	4	13.3	30	100	

Table 6 shows that more people in the intervention group did not experience obstetric complications compared to the control group. Of the 30 respondents in the intervention group, 26 respondents (86.7%) did not experience obstetric complications, while in the control group, 18 people (60%) did not experience obstetric complications. Respondents in the intervention group who experienced obstetric complications were 4 respondents (13.3%), while in the control group, there were 12 people (40%). This shows that more respondents in the intervention group did not experience obstetric complications when compared to the control group.

The p-value of the chi-square test shows a figure of 0.020. Because the p-value is less than 0.05 (0.020 <0.05), it can be concluded that the SiPantau Bumil application has an effect on obstetric complications.

DISCUSSION
1. **Influence of Characteristics on K6 Visits**.
a. **The Effect of Age on K6 Visits**
The results showed that age had no influence on K6 visits. The p-value of the chi-square test shows a figure of 0.172. Because the p-value is more than 0.05 (0.172>0.05), it can be concluded that age has no influence on K6 visits.

Age has no effect on K6 visits because the respondents in this study were high-risk pregnant women so they were aware of the importance of pregnancy checks in order to maintain the health of themselves and the fetus they are carrying. The research results of Qomar et al., (2021) also found that age does not influence antenatal care visits. This makes it possible for pregnant women to feel that the health of the mother and fetus during pregnancy is considered important so that they continue to carry out visits according to schedule. Pregnancies in at-risk groups can be controlled with appropriate antenatal care. This is done by detecting risks and complications early so as to make it easier for health workers to provide safe pregnancy care and birth planning according to the level of risk experienced (Qomar et al, 2021).

b.   The Influence of Education on K6 Visits

The results showed that education did not influence K6 visits. The p-value of the chi-square test shows a figure of 0.083. Because the p-value is more than 0.05 (0.083>0.05), it can be concluded that education has no influence on K6 visits.

A person's education is a predisposition that determines a person's health behavior. Predisposing factors are factors that facilitate or predispose someone's behavior to occur (Devy & Aji, 2023). These results are in line with research Lorensa that there is no relationship between education and antenatal care visits. Pregnant mothers not always highly educated behave positively, and so do pregnant women not always with low education behavior (Lorensa et al, 2021).

c.   The Effect of Work on K6 Visits

The results showed that work had no influence on K6 visits. The p-value of the chi-square test shows a figure of 0.121. Because the p-value is more than 0.05 (0.121>0.05), it can be concluded that work has no effect on K6 visits.

The results of this study are in line with the research (Kiah, Kaltsum & Saleh, 2023) which shows that the mother's job does not affect K6 coverage. Work shows that most working and non-working mothers have complete antenatal visits. The statistical test results showed that there was no relationship between employment and antenatal visits at the Alak Health Center. The results of other research also show that there is no significant relationship between the respondent's job and the regularity of carrying out regular K6 inspection visits (Sari et al., 2021).

d.   The Effect of Income on K6 Visits

The research results show that income influences K6 visits. The p-value of the chi-square test shows a figure of 0.004. Because the p-value is more than 0.05 (0.004<0.05), it can be concluded that income affects K6 visits.

The results of this research are in line with the research (Kiah, Kaltsum & Saleh, 2023) which shows that the income obtained from the family will influence K6 visits. According to (Kiah, Kaltsum & Saleh, 2023) mothers with high family incomes are three times more likely to make antenatal visits compared to families with lower incomes. This research is in line with what Kiah, Kaltsum, & Saleh, (2023) di family income with K6 antenatal visit at the Community Health Center Alak points out that most mothers with high family income have a complete visit. Results Statistics also show that there is a relationship between income and visits antenatal, where a mother with a high family income is a possibility make regular antenatal visits complete 3 times compared to mothers with a low family income. The results of other studies also state that there is a relationship between knowledge and family income in antenatal care visits (Kiah, Kaltsum, & Saleh, 2023). On the other hand, pregnant women's family income is low, they tend to allocate family finances to fulfill their family's basic needs (Oktava, 2019). Economic limitations can encourage pregnant women not to have routine check-ups because they cannot afford to pay (Zega, Tambunan, & Barus, 2023).

e.   The Effecr Husband's Support on K6 Visits

The results showed that the husband's support had an influence on K6 visits. The p-value of the chi-square test shows a figure of 0.000. Because the p-value is less than 0.05 (0.000<0.05), it can be concluded that the husband's support influences K6 visits.

According to (Aryanti, Karneli, & Sella, 2020) pregnant women will always carry out complete pregnancy checks if they receive good support from their husbands. Husband's support has a significant impact on the success of antenatal care because good support given

by a husband to his wife will affect the physical and psychological condition of pregnant women so that mothers will receive regular antenatal care. Husband's support, especially in the form of instrumental support as shown by always providing attention and affection, advising the wife to have a pregnancy check-up, accompanying her during the pregnancy check-up, and knowing and being alert to her wife's condition during pregnancy (Aryanti, Karneli, & Sella, 2020).

Family support is not the only support where there is also support from people around and health workers who are ready to support, and the pregnant mother herself is a decision maker who will decide whether to visit antenatal care or not (Cahyani, 2020). Husband's support plays an important role in influencing the psychology and enthusiasm of pregnant women. Support in the form of attitudes and actions such as assistance, attention, appreciation or concern for pregnant women will make a good contribution to pregnant women in utilizing ANC services regularly (Tassi et al, 2021).

f.   The Influence of Mother's Attitudes on K6 Visits

The results showed that the mother's attitude towards the importance of pregnancy check-up visits had an influence on K6 visits. The p-value of the chi square test shows a figure of 0.000. Because the p-value is less than 0.05 (0.031<0.05), it can be concluded that attitude influences K6 visits.

The attitude of mothers who agree about the importance of pregnancy checks will influence the intensity and compliance of mothers in carrying out pregnancy checks. Mothers who believe that pregnancy checks are important and can maintain the health of the mother and her baby will make the mother always have her pregnancy checked regularly by health workers. Mother will always remember and ask for a schedule of when she has to make a return visit.

2.   Influence of Characteristics on Obstetric Complications.
a.   The Effect of Age on Obstetric Complications

The research results show that age has an influence on obstetric complications. This can be seen from the p-value of the chi-square test which shows a figure of 0.037. Because the p-value is less than 0.05 (0.037<0.05), it can be concluded that age has an effect on obstetric complications.

The risk of pregnancy arises in pregnant women who are less than 20 years old and when the mother is more than 35 years old, in young mothers, obstetric complications that appear in the form of bleeding at a young gestational age, birth of preterm babies, LBW, congenital abnormalities, easily being attacked by viruses or bacteria, low hemoglobin levels, poisoning in pregnancy (gestosis) and death (Sukma, & Sari, 2020). Younger women will tend to have broader knowledge than older women because times have changed a lot and technology is more advanced so it is very easy to access the information they want (Komariah & Nugroho, 2020).

b.   The Effect of Education on Obstetric Complications

The research results showed that education had no influence on obstetric complications. This can be seen from the p-value of the chi square test which shows a figure of 0.159. Because the p-value is more than 0.05 (0.159>0.05), it can be concluded that education has no effect on obstetric complications.

The results of this study show that education has no effect on obstetric complications, this is because even though the respondents are in the basic education category, they receive good information about health so they will always maintain their health through routine

pregnancy check-ups. Education is an effort to develop personality and abilities inside and outside school (both formal and non-formal), lasting a lifetime (Nabila, Dewi, & Immawati, 2022).

Education will influence the mother's knowledge. Pregnant women who have high knowledge will certainly understand what is good for themselves and their fetus, for example, keeping their child at a distance to avoid high-risk pregnancies because the child is too close. Pregnant women who have low knowledge but do not experience high risk are supported by good health conditions where there are no problems or risk factors originating from within the mother (Fitrianingsih, Suindri, & Armini, 2019).

Education has a significant influence on maternal mortality, where the level of education possessed by pregnant women influences whether or not maternal death occurs. The high maternal mortality rate is partly due to the very low level of education of mothers. Women who have a high level of education tend to pay more attention to the health of themselves and their families, while women with a low level of education result in a lack of understanding of the dangers that can befall pregnant women, especially in terms of pregnancy and childbirth emergencies (Karyati, 2021).

c.   Effect of Work on Obstetric Complications

The results of the study showed that work had no influence on obstetric complications. The p value of the chi square test shows a figure of 0.085. Because the p value is more than 0.05 (0.085>0.05), it can be concluded that work has no effect on obstetric complications.

The results of this study are in line with research conducted by Murdiati and Jati (2017) which concluded that work has no effect on obstetric complications. This is because the work carried out by pregnant women is not a factor that directly influences behavior change (Murdiati & Jati, 2017).

d.   The Effect of Income on Obstetric Complications

The research results show that income has an influence on obstetric complications. The p-value of the chi-square test shows a figure of 0.004. Because the p-value is less than 0.05 (0.004<0.05), it can be concluded that income has an effect on obstetric complications.

The results of this study are in line with the research (Fitrianingsih et al., 2019) which concluded that income influences obstetric complications. According to (Fitrianingsih et al., 2019) socio-economic conditions in the family will influence the nutritional needs of pregnant women and their families, including their efforts to carry out pregnancy care and examinations. Making a correct diagnosis early will be able to prevent obstetric complications resulting from high-risk pregnancies. Income problems that occur cause obstacles to obtaining health services, which can increase maternal morbidity and mortality. In communities that have high economic conditions, family health status also increases (Andini & Julia, 2022).

e.   The Effect of Husband's Support on Obstetric Complications

The results showed that the husband's support influenced obstetric complications. The p-value of the chi-square test shows a figure of 0.000. Because the p-value is less than 0.05 (0.000<0.05), it can be concluded that the husband's support affects obstetric complications.

With the husband's role as a good partner for his wife in maintaining pregnancy, of course, he will be alert to the possibilities that will happen to his wife, including the possibility of obstetric complications. The husband's support will be able to reduce the possibility of complications occurring in the mother. Research conducted by Pramasanthi, (2016) concluded that husband's support influences obstetric complications. According to

Pramasanthi, (2016), if pregnant women and their partners are given the right information about the importance of pregnancy checks, it will have a significant impact on the mother's regularity in carrying out pregnancy checks compared to only the mother receiving counseling. The support given by the husband to the mother can give rise to inner calm and feelings of joy that give rise to a positive attitude towards oneself and the pregnancy (Farida, Kurniawati, & Juliningrum, 2019).

f.   The Influence of Mother's Attitudes on Obstetric Complications

The research results show that attitude has an influence on Obstetric Complications. The p-value of the chi-square test shows a figure of 0.000. Because the p-value is less than 0.05 (0.000 <0.05), it can be concluded that attitude influences obstetric complications.

The influence of attitudes towards obstetric complications is due to the fact that the mother agrees with the importance of pregnancy checks as an effort to prevent the occurrence of obstetric complications.

3.   The influence of the GIS-based Sipantau Bumil application on K6 visits

The results of the study showed that pregnant women who were given the application intervention had more K6 visits compared to pregnant women who were not given the intervention. In the intervention group, the number of pregnant women who underwent K6 visits was 25 respondents (83.3%) out of a total of 30 pregnant women who received the intervention. In the intervention group there were 5 respondents who did not make the K6 visit because 1 respondent had preterm labor, 2 respondents had made an appointment with the officer to make the K6 visit but it was not yet time to make an appointment for the K6 visit. The respondent was already in labor and 1 respondent did not have time. made a K6 visit because he was busy working. Meanwhile, in the control group, the number of mothers who made K6 visits was 16 (53.3%) out of a total of 30 mothers in that group.

The Chi Square Test results show that there is an influence of using the GIS-based Sipantau Bumil application on K6 visits. The p value is 0.012 from 0.05 (0.012<0.05), so it can be concluded that the GIS-based surveillance application for pregnant women has an effect on K6 visits.

The "GIS-Based siPantau Bumil" application is an application developed to increase the coverage of K6 visits. "GIS-Based Pregnancy Monitoring" which can provide information on the location of pregnant women, types of risks for pregnant women, K6 visit schedule for pregnant women, types of obstetric complications, education and care that can be given to pregnant women so that it will make it easier for midwives to carry out monitoring of pregnant women which has an impact. will increase coverage of K6 visits.

With the various features this application has, it has been statistically proven to have an effect on K6 visits for high-risk pregnant women in Pekalongan City. Where the results of the hypothesis test obtained a p-value <0.05. There is an influence of "GIS-based pregnant monitoring" on K6 visits because the use of this application is able to provide notification of the K6 visit schedule that must be carried out by pregnant women. If a pregnant mother has not had a K6 visit, the notification on the application will continue to flash so that the local midwife understands who the mothers are who have not had a K6 visit. Apart from that, it can also help officers to monitor whether pregnant women have had K6 visits via active WA chat carried out by officers/midwives for pregnant women. The siPantau Bumil application also provides educational features in the form of text and attractive images so that it can increase pregnant women's knowledge about health or ANC visits which is expected to increase pregnant women's awareness of the importance of regular ANC visits. Research by Ismayanty

et al., (2020) shows that providing a mobile application increases mothers' knowledge about pregnancy risk factors (Ismayanty et al., 2019).

4. The Effect of the GIS-Based SiPantau Pregnancy Application on Obstetric Complications

The results of the study showed that pregnant women who were given intervention in the form of the GIS-based Sipantau Bumil application did not experience obstetric complications more often than 26 respondents (86.7%). In the intervention group, there were 4 respondents who experienced obstetric complications. The types of complications experienced by these respondents were: Meanwhile, in the control group, 18 respondents (60%) did not experience obstetric complications.

The results of the Chi-Square Test show that there is an influence of using the GIS-based Sipantau Bumil application on obstetric complications. The p-value of 0.020 is less than 0.05 (0.020 <0.05), so it can be concluded that the GIS-based SiPantau Bumil application is against obstetric complications.

Obstetric complications are defined as pain in pregnant women, women giving birth, and postpartum women which can threaten the life of the mother and/or baby. In Pekalongan City, with high cases of obstetric complications, high mobility of pregnant women and the absence of village midwives who can monitor 24 hours in the village, of course, this requires intervention to improve monitoring and management of data collection related to the distribution of pregnant women so that pregnant women can be monitored well.

The results of this study indicate that the use of the GIS-based pregnancy monitoring application can influence obstetric complications, where in the intervention group the number of mothers who experienced obstetric complications was smaller compared to the control group. The influence of GIS-based Sipantau Pregnancy on reducing obstetric complications is due to several things, including this application can provide notifications for inspection visits, this application is equipped with educational features, the educational feature on the GIS-based Sipantau Pregnancy application provides some information on the problems of obstetric complications that can occur. The use of text, audio, and video self-care tutorials in the application makes it easier for respondents to get information easily because audio-visual media uses hearing and seeing elements or uses more than one sense (Indrawati, 2018).

Apart from that, this application also has a chat feature with a midwife, this chat feature allows pregnant women to get counseling with a midwife regarding the condition of their pregnancy. With this chat feature, mothers/patients can connect with health workers at any time. In certain conditions, if a pregnant woman experiences complaints that lead to obstetric complications, the mother can communicate with the local midwife so that the midwife will be able to immediately respond to the complaints experienced in the form of suggestions or immediate action to carry out obstetric management. Obstetric management that can be provided quickly by midwives to patients will be able to minimize the incidence of obstetric complications experienced by mothers. Thus, the use of the GIS-based siPantau Bumil application has an influence on obstetric complications.

4. CONCLUSION

The research results show that age, education, and employment have no effect on K6 visits, while income, husband's support, and attitude have an effect on K6 visits. The research results also showed that age, income, husband's support, and attitude had an influence on obstetric complications, while education and employment had no effect on obstetric complications. The research results show that the GIS-based pregnant monitoring application has an effect on increasing K6 visits and reducing obstetric complications.

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R E S E A R C H   **Open Access**

In Silico Coformer Screening for Mefenamic Acid Cocrystallization

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Abstract
Cocrystallization is a widely used approach to enhance the solubility and dissolution characteristics of poorly soluble drugs. A pharmaceutical cocrystal is a multicomponent system composed of a solid active pharmaceutical ingredient (API) and a coformer, governed by non-covalent interactions. Screening for suitable coformers is essential to obtain an optimal cocrystal for specific drugs. This study aims to determine the drug-coformer interactions to select the most suitable coformer for cocrystal formation using the molecular docking method. Mefenamic acid, classified as a class II drug in the biopharmaceutical classification system (BCS), was used as the model drug. Two-dimensional structures of mefenamic acid (PubChem CID: 4044) and potential coformers were sourced from PubChem. Geometric optimization of all compounds was performed using GaussView 5.0.8 and Gaussian09 with the 3-21G basis set and Density Functional Theory (DFT) B3LYP method. The optimized compounds were prepared by adding hydrogen atoms and calculating Kollman partial charges using AutoDock 4.2. A grid box of size $40 \text{ Å} \times 40 \text{ Å} \times 40 \text{ Å}$ was generated, with a maximum radius of 0.375 Å set as the surface distance in each simulation. A hundred conformations were run using the Lamarckian Genetic Algorithm. Interaction types and binding energies were analyzed using VMD 1.9.2 and BIOVIA Discovery Studio 2020 to compare interactions between mefenamic acid and each coformer. The results revealed that most coformer compounds formed interactions with mefenamic acid via hydrogen bonding and π–interactions. Saccharin demonstrated the most optimal interaction with mefenamic acid, with a binding free energy of –3.1 kcal/mol. Saccharin was identified as the most suitable coformer for mefenamic acid cocrystal formation based on the molecular docking study. Further experimental validation of saccharin is recommended to confirm its effectiveness in cocrystallization with mefenamic acid.

Keywords: Cocrystal, Coformer, Screening, Molecular Docking, Mefenamic Acid.

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1. INTRODUCTION

To achieve optimal efficacy, solid active pharmaceutical ingredients (APIs) need to have certain aqueous solubility to ensure absorption through gastrointestinal fluid. However, despite their abundance and various pharmacological activities, solid crystalline APIs are still suffering from limited solubility (Bhandaru et al., 2015). Several drug modifications, such as by formation of different polymorphs, inclusion complexes, and cocrystals, have been extensively studied to overcome the physicochemical limitations of the drug in providing therapeutic effects (Censi & Di Martino, 2015; Putra et al., 2018).

A pharmaceutical cocrystal is a stoichiometrically defined multicomponent crystalline structure consisted of an API and a cocrystal former (coformer) (Karimi-Jafari et al., 2018). Several aspects, i.e., physical form, molecule size, functional group types, and "generally recognized as safe (GRAS)" status must be considered when using a compound as a coformer (Singh et al., 2023). From previous works, it is shown that several types of acids such as ascorbic acid, benzoic acid, citric acid, fumaric acid, stearic acid, and succinic acid, as well as nicotinamide and saccharin, were universally acknowledged as potential coformers in cocrystal formation (Wouters et al., 2011).

Several types of non-covalent intermolecular interaction, such as hydrogen bonding, halogen bonding, van der Waals force, or π-interaction may govern the binding between drug and coformer molecules (Berry & Steed, 2017). Among those interactions, hydrogen bonding is viewed as primary interaction in the cocrystal formation. Thus, to perform cocrystallization, both drug and coformer molecules must contain hydrogen bond donor or hydrogen bond acceptor sites (Li et al., 2018).

In the development of pharmaceutical cocrystal, selection of suitable coformer(s) is an important preliminary step to predict cocrystallization ability of drug-coformer, and subsequently obtaining cocrystal with better properties and performance compared to the parent drug (Mangesh et al., 2019). Both experimental approaches and computational approaches have been employed in coformer screening for designing cocrystals (Musumeci et al., 2011). Computational-based screenings are considered more favorable in terms of efficiency and cost-perspective. Several computational methods, such as crystal structure prediction using Cambridge Structural Database (CSD), conductor-like screening model for real solvents using COSMO-RS, molecular electrostatic potential surfaces (MEPS), lattice energy calculations, Hansen solubility parameters, and molecular docking-based screenings have been able to effectively predict the formation of cocrystal (Khalaji et al., 2021; Kumar & Nanda, 2021; Mohammad et al., 2011; Siswandi et al., 2015).

In this work, we use mefenamic acid (2-[(2,3-dimethylphenyl)amino]benzoic acid) as model drug for cocrystal formation. Mefenamic acid is a nonsteroidal anti-inflammatory drug (NSAID) with various pharmacological activities, including analgesic and antipyretic (Cimolai, 2013). According to the biopharmaceutical classification system (BCS), mefenamic acid is included in class II due to low solubility–high permeability characteristic (Nurhikmah et al., 2016). Mefenamic acid modification toward cocrystal form is a viable option to enhance its solubility and dissolution rate (Utami et al., 2017). The purpose of this study is to explore the interaction between mefenamic acid and several compounds as coformer candidates using molecular docking approach. Binding affinities of drug and coformer molecules were determined based on calculated interaction energy.
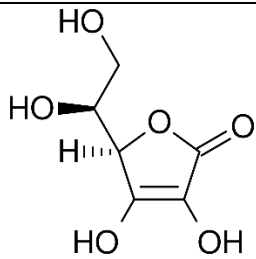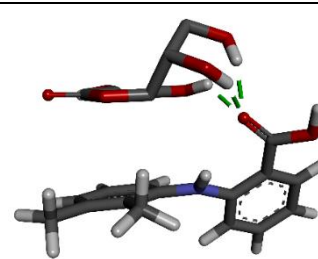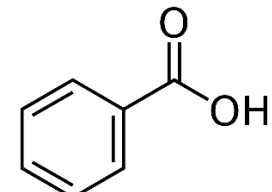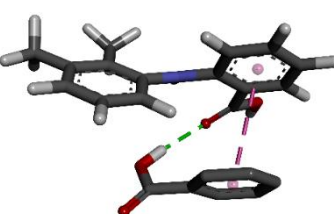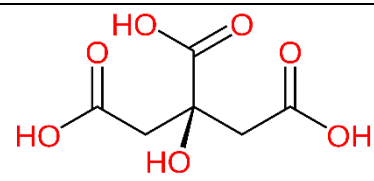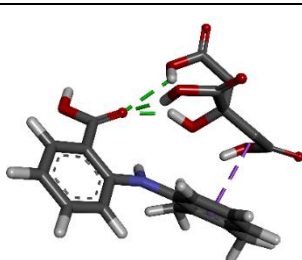
2. RESEARCH METHOD

The simulation in this study was performed using 6-cores (@4.30 GHz) computing unit runs on dual operating systems (Windows 10 and Linux Ubuntu 18.10). Two-dimensional structures of mefenamic acid (PubChem CID: 4044) and the coformers were acquired from

pubchem.ncbi.nlm.nih.gov. All compounds were geometrically optimized using GaussView 5.0.8 and Gaussian09 with the 3-21G base set Density Functional Theory (DFT) B3LYP method. Optimized compound files were then prepared by inserting hydrogen atoms and calculating Kollman partial charges using AutoDock 4.2. Grid box with the size of 40 Å × 40 Å × 40 Å was generated, and maximum radius of 0.375 Å was set as surface distance in each simulation. A hundred conformations were run using Lamarckian Genetic Algorithm throughout the process. Interaction type and binding energy of interaction were observed using VMD 1.9.2 and BIOVIA Discovery Studio 2020 to compare the interaction between mefenamic acid and each coformers.

3. RESULTS AND DISCUSSION

The two-dimensional structure of coformers and visualized interaction types of mefenamic acid-coformer interaction from molecular docking simulation are presented in Table 1.

Table 1. Interaction types of mefenamic acid-coformer based on molecular docking result
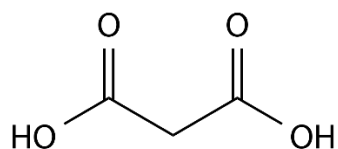
Coformer	2D Structure	Interaction
Ascorbic Acid		Hydrogen bond
Benzoic Acid		Hydrogen bond π– π interaction
Citric Acid		Hydrogen bond π– σ interaction
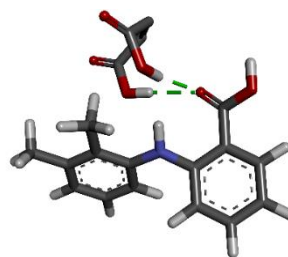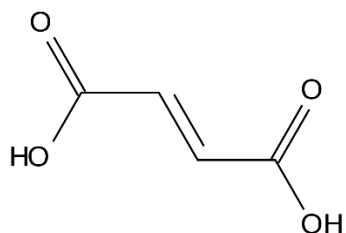
Fumaric Acid		Hydrogen bond
Malonic Acid		Hydrogen bond
Methylparaben		Hydrogen bond $\pi-\pi$ interaction
Nicotinamide		Hydrogen bond $\pi-\pi$ interaction
Saccharin		Hydrogen bond $\pi-\pi$ interaction
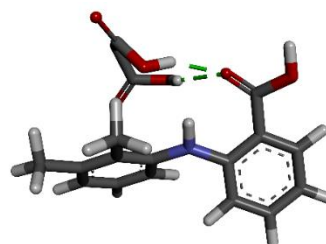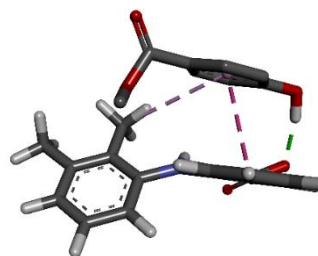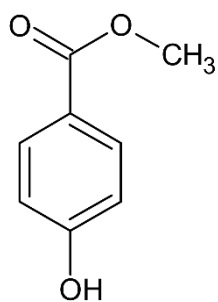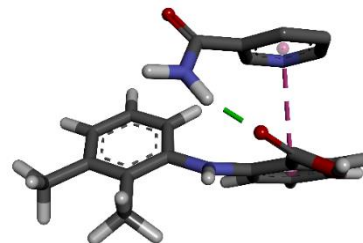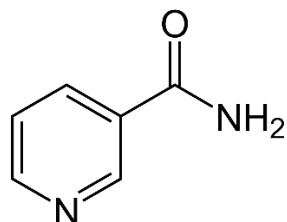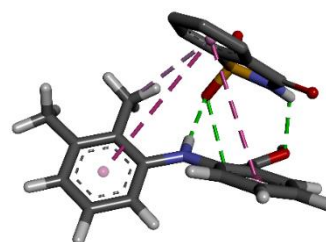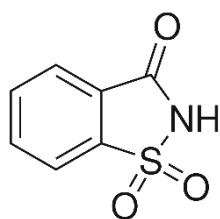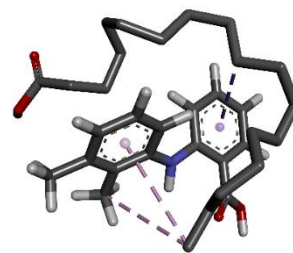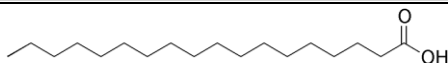
Stearic Acid	
	π– σ interaction
Succinic Acid	
	no interactions
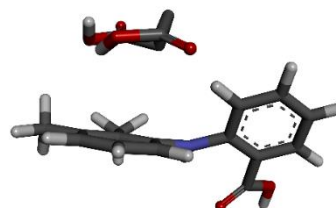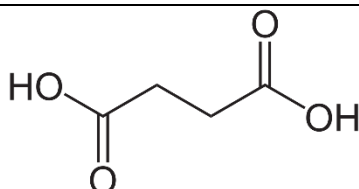
Mefenamic acid contains two hydrogen bond donors (hydrogen atoms in –COOH and –NH), and three hydrogen bond acceptors (oxygen atoms in –COOH and nitrogen atom in –NH) (Gajjar et al., 2013). Intermolecular hydrogen bonding between mefenamic acid molecules and coformer molecules may be identified in these sites. According to the molecular docking result, it is observed that the majority of the compounds, with the exception of stearic acid and succinic acid, were able to generate hydrogen bonding interaction with mefenamic acid. In conventional synthesis, the presence of hydrogen bond reflects the stability of the cocrystal due to the strong complementary pairing of hydrogen bond donor and acceptor moieties (Taylor & Day, 2018). Thus, it is more favorable for the cocrystal system to have such interaction.
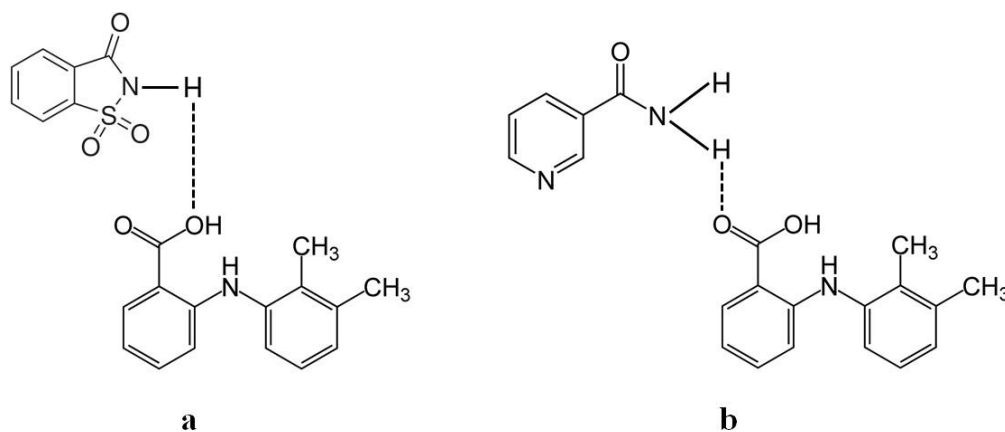

Figure 2. Predicted hydrogen bonding of mefenamic acid-saccharin (a) and mefenamic acid-nicotinamide (b) based on molecular docking result.

Figure 2 illustrates a closer inspection of hydrogen bonding in mefenamic acid-saccharin and mefenamic acid-nicotinamide based on molecular docking prediction. It is shown that the hydrogen bond in both systems have resulted from amide-carboxylic acid (N–H⋯O) interaction. The acid-amide heterosynthon is considered the most commonly recognized hydrogen bonding interaction in cocrystal formation (Saha & Desiraju, 2018). Furthermore, it has been argued that the strength and high-directiveness of N–H⋯O may lead to a robust synthon, hence increasing the probability of stable cocrystal structure (Vener et al., 2014).

The presence of two aromatic rings in mefenamic acid structure is also worth pointing out, since these rings are responsible for intermolecular π-interactions between drug and the coformer. From geometrical perspective, aromatic rings can form interaction through edge-to-face (T-shaped), face-to-face stacked (sandwich), or parallel-displaced stacked motifs (Bora et al., 2018). The latter motif is considered the most energetically favorable, since its orientation enables attractive interaction between positively charged σ-bond with negatively charged π-electron density. While face-to-face motif considered unfavorable due to π–π repulsive interaction (Grimme, 2008). From docking results, it is indicated that π–σ interactions were present between mefenamic acid with citric acid and stearic acid. While π–π interactions were occurred between mefenamic acid with benzoic acid, methylparaben, nicotinamide, and saccharin. Both T-shaped and parallel-displaced π–π motifs were depicted solely on the interaction between mefenamic acid with saccharin, implying the more energetically favorable conformation. The energetic favorability of a system directly represents the spontaneity of a process (Sarcevica et al., 2013).

Table 2. Interaction energy of mefenamic acid-coformer based on molecular docking result

Coformer	ΔG (kcal/mol)	$E_{inter-mol}$ (kcal/mol)	E_{VHD} (kcal/mol)	E_{elec} (kcal/mol)	E_{total} (kcal/mol)	$E_{torsional}$ (kcal/mol)
Ascorbic Acid	–1.98	–3.77	–3.18	–0.60	–2.50	+1.79
Benzoic Acid	–1.38	–1.97	–2.36	+0.39	–0.02	+0.60
Citric Acid	+1.16	–1.53	–2.69	+1.17	–2.72	+2.68
Fumaric Acid	+0.07	–1.12	–1.96	+0.84	–0.33	+1.19
Malonic Acid	+0.21	–0.98	–1.98	+1.00	+0.05	+1.19
Methylparaben	–2.27	–3.16	–2.90	–0.26	–0.12	+0.89
Nicotinamide	–2.38	–2.68	–2.41	–0.26	+0.01	+0.30
Saccharin	–3.10	–3.10	–3.05	–0.05	–0.00	–0.00
Stearic Acid	+1.15	–3.92	–4.00	+0.08	–0.80	+5.07
Succinic Acid	+0.55	–0.95	–1.20	+0.25	–0.68	+1.49

Table 2 depicts the energies of involved interaction in mefenamic acid-coformer systems. ΔG estimated the free energy of binding, $E_{inter-mol}$ is the final intermolecular energy (E_{VHD} + E_{elec}), E_{VHD} (van der Waals + hydrogen bonding + desolvation energy), E_{elec} is the electrostatic energy, E_{total} is the final total internal energy, and $E_{torsional}$ is the torsional free energy. It is observed that the intermolecular interaction between mefenamic acid and coformer compound is dominated by E_{VHD}, signifying the contribution of non-covalent van der Waals and hydrogen bonding to the formation of cocrystal (Liu et al., 2018). Additionally, a more negative ΔG value indicates a more energetically favorable system, which subsequently demonstrates a more spontaneous process due to lower energy of formation (Zhang et al., 2017). Analysis of binding free energy also offers a quantitative approximation toward the stability of a thermodynamic system. This implies a direct relationship between the spontaneity of the process and the stability of the structure (Tahir et al., 2019). It can be seen that mefenamic acid interaction with saccharin generates the lowest binding free energy (–3.10 kcal/mol), thus offering the possibility of a stable cocrystal formation.

4. CONCLUSION

Coformer screening for mefenamic acid cocrystallization has been investigated using molecular docking method. From docking result, it is revealed that the majority of coformer

candidates were able to form interaction with mefenamic acid via hydrogen bonding and π–interaction. Based on calculated binding energy, saccharin (–3.1 kcal/mol) had the most optimal binding affinity with mefenamic acid, indicating the possibility of stable cocrystal formation. Further experimental studies may be performed to confirm the result and reveal the ability of coformer candidates in the formation of cocrystal with mefenamic acid.

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R E S E A R C H　　　　　　　　　　　　　　　　**Open Access**

Concept Analysis of Resilience in Adolescent Living with HIV: Review of Limitations and Implications

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Abstract
Resilience is characterized by 'the ability to bounce back from challenge and adversity'. However, being Adolescent Living with HIV (ALHIV) give larger challenges on an individual throughout their life because of their characteristic and illness. After all, positive results such as resilience are also feasible, yet knowledge on resilience in ALHIV remains limited and resilience assessment methods continue to be debated and need further clarification of the concept of resilience is needed about this population. In recent years, empirical research on resilience has grown, criticism have been mostly concentrates on ambiguity definition and implications. This concept analysis aims to identify the concept of the resilience ALHIV by identifying the attributes that determine the concept, antecedents and consequences. This study tries to discover the traits that determine the concept of resilience in ALHIV using Walker and Avant's approach, with searches performed in the CINAHL, PubMed, Science Direct and PsycInfo. The results of the analysis reveal the resilience antecedents of ALHIV such as coping strategy, illness acceptance, positive adaptation, self-efficacy, positive future expectation, emotional regulation, family support, school connectedness and healthcare support. The consequences of the concept of resilience in ALHIV include positive outcomes include improved adherence to treatment, psychological well-being, positive coping strategy, better school performance and positive social relationship.

Keywords: Adolescent, ALHIV, Concept Analysis, HIV, Resilience.

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1. INTRODUCTION

In 2021, 3.3 million adolescents aged between 15 until 24 were living with HIV. Adolescents living with HIV (ALHIV) experience larger impact on an individual throughout their life because of their characteristic and their illness. Besides that, ALHIV are in the transition period from children to adult care, which is a complex and challenging process (Bailey et al. 2017).

However, being diagnosed with a chronic illness can give long term impact on psychological, socio-spiritual and emotional function (Mardhiyah et al. 2020). HIV is a potentially traumatic experience that can affect mental health and lead to increased anxiety and depression (Kip et al. 2021). HIV infection puts ALHIV in a challenging and stressful situation (Vreeman, McCoy, and Lee 2017).

In addition, girls living with HIV have a higher risk of abortion and premature birth (Mkumba et al. 2021; UNICEF 2023), ALHIV more likely to experience physical violence (Kimera et al. 2019; Ramaiya et al. 2016). Apart from that, what ALHIV often experiences are stigma and discrimination especially from other students, teachers or other staff (Kimera et al. 2019). ALHIV also have problems to participating in HIV care and in adjusting treatment time to their academic schedules (Abimanyi-Ochom et al. 2017).

After all, positive results such as resilience are also feasible. Resilience is characterized by 'the capacity of an individual or object to reorganize itself' or 'the ability to bounce back from difficulties' (Yosep, Sriati, and Suryani 2023). Resilience is defined as the ability of an individual to 'roll with the punches' (Edward et al. 2014). Resilience is the capacity to rise above difficult circumstances, the trait that allows us to exist in this imperfect world while moving forward with hope and confidence (Ginsburg and Jablow 2020).

For this purpose, government and stakeholders establish programs or interventions such as Baylor College of Medicine International Pediatric AIDS (BIPAI) arrange Teen Club program that focuses on psychosocial problems and supports ALHIV in Botswana which already has 800 members (UNICEF, 2023). Meanwhile, Pediatric-Adolescent Treatment Africa (PATA) developed the Re-Engage Adolescents and Children with HIV (REACH) program which is also implemented in several countries where as focusing on psychosocial peer support and building resilience in ALHIV (Mark et al. 2017). But despite those programs, ALHIV still facing challenges to improve resilience.

Recognizing the importance of ALHIV resilience is crucial for improving their well-being and livelihoods (Kaunda-Khangamwa et al. 2020). According to the explanation above, the author interested in discussing subjects related to resilience and ALHIV. Several studies have also demonstrated a correlation between resilience and ALHIV. Resilience is positively correlated with well-being, helps ALHIV accept their diagnosis and develop optimism, improves ART adherence and protective factor for mental health.

Although resilience is well understood in adults, there is still lack theoretical definition of the concept in adolescent. Examining the concept of resilience in adolescent, especially those who living with HIV, as developmental stressor that are part of the normal process of adolescent and their status as a patient HIV may create unique barriers to this process.

2. RESEARCH METHOD

This concept analysis using The Walker and Avant framework guide, following the the modified of 5 steps; (a) selection concept; (b) determine the aims of the analysis; (c) identification of uses context; (d) determination of its defining atributes; and (e) definition of its empirical referents.

A comprehensive literature search was conducted through PubMed, CINAHL, Science Direct and PsycInfo. to identify current of the concept. The following keywords are 'resilience'

or 'resilient' and 'Adolescent Living With HIV' or 'ALHIV' and 'definition' in all text fields, respectively. Combined with Boolean value, 121 articles were found from 2014-2024. The phrase "resilience in adolescent with HIV" was also searched through Google to identify additional articles and uses of the concept. One reviewer screened all articles for eligibility. To be eligible, articles must have included HIV that were consistent with specified definition, included adolescents and depicted a use or reference of resilience. The following exclusion criteria were placed during article selection: (a) articles on other illness due to different care implications of these conditions (b) absence discussion on resilience.

3.   RESULTS AND DISCUSSION

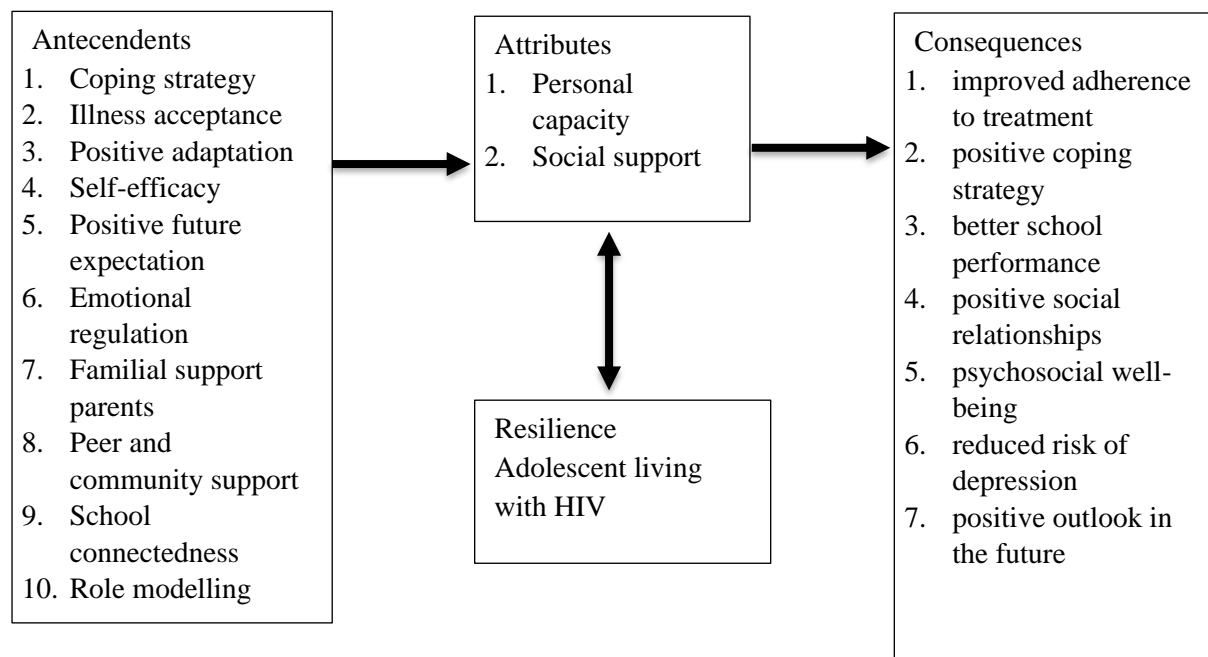| Antecendents	Attributes	Consequences
1. Coping strategy 2. Illness acceptance 3. Positive adaptation 4. Self-efficacy 5. Positive future expectation 6. Emotional regulation 7. Familial support parents 8. Peer and community support 9. School connectedness 10. Role modelling	1. Personal capacity 2. Social support Resilience Adolescent living with HIV	1. improved adherence to treatment 2. positive coping strategy 3. better school performance 4. positive social relationships 5. psychosocial well-being 6. reduced risk of depression 7. positive outlook in the future

Figure 1. concept analysis of the resilience of ALHIV

Figure 1 illustrate the attributes of resilience in adolescent living with HIV that can find on the literature.

a.   Resilience in the literature

The phrase "resilience" was first used from pshysics, where it refers to the ability of solid bodies to regain its shape under mechanical pressure. Resilience was initially discussed in psychological literature in the 1950s in the terms of unconscious defence mechanisms. The concept resiliency was first used in the context of mental health to examine children with mental health issues who displayed resilience in face of challenging adversity and challenging situations.

Research in many psychology domains aims to determine whether resilience is a dynamic condition or a personality trait. Varying methodologies have resulted in differences in defining this term. In psychology, resilience related to the individual positive adaptation to cope with adversity or challenge during life (Adams et al. 2021). Resilience is not a fixed trait, but rather a dynamic process that can be developed and strengthened over time through various factor (Betancourt et al. 2013; Oktapia and Huwae 2023).

b.   **Defining attributes**

According to the recurring finding on the literature subject, resilience is primarily built on adversity and positive adaptation. The key traits of adolescent who have a high level of resilience may typically be categorized in two main categories; personal capacity and social support or external environment resources.

c.   **Model case**

"…Miss K is a 15-years-old, female, student who diagnosed by HIV at birth and has been on antiretroviral therapy (ART) for as long as she can recall. Miss K lives with her grandmother as her parents passed away due to AIDS-related illness. Miss K experienced challenges due to the side effects of HIV treatment, the schedule (opening and closing) hours which conflict with school hours, the expectation to have their own family, the stigma associated with the disease and stressful circumtances. Despite these challenges, Miss K is a diligent and engaged student at her school. She has a close friends in peer group who support her and knows how to manage her condition well. Miss K understands the importance of taking her medication regularly and follows her treatment plan diligently. Miss K experienced positive outcomes such as improved physical health, the capacity to engage in activities, socialize, and longer life expectancy. Miss K sees her HIV diagnosis as a part of her life but does not let it define her."

d.   **Borderline case**

"…D is a 17-year-old boy who was diagnosed with HIV two years ago. He lives with his single mother, who is also living with HIV. D response at that time was confusion, anger, denial and sadness. Until now, D struggles with feelings of anger and resentment about his diagnosis, often questioning why this happen to him. D struggles with adherence to his antiretroviral medication, often forgetting to take it or skipping doses and denied to take counselling related to her treatment. He feels isolated from his peers and has low self-esteem because of his HIV status. He has a few close friends at school but often feels isolated and misunderstood. He is worried about her future life and fears of stigma from the surrounding people."

e.   **Antecedents**

In the case of adolescents with HIV, there are some antecedents refer to the cause of the development of resilience such as changes in physics due to ART, experience of adversity, stigma, orphanhood, complicated grief, and struggling to following HIV treatment (Abimanyi-Ochom et al. 2017; Kaunda-Khangamwa et al. 2020; Ramaiya et al. 2016; Vreeman et al. 2017).

Numerous studies had been conducted to investigate why some adolescent effectively navigate hardships while others unable, the antecedents to enhancing the resilience of adolescent living with HIV. Personal capacity can be the resource of individual resilience coping strategies (Bhana et al., 2016; Crowley et al., 2021; Dow et al., 2018), illness acceptance (Dow et al. 2018; Harper et al. 2019), positive adaptation (Crowley et al. 2022; Harrison and Li 2018), self-efficacy(Antelman Id et al. 2022; Dulin et al. 2018; Oktapia and Huwae 2023), positive future expectation(Li et al. 2015; Oktapia and Huwae 2023) and emotional regulation(Chen, Huang, and Lin 2022; Mestre et al. 2017; Surzykiewicz et al. 2022) are critical contextual factors that facilitate resilience processes.

Social support resource plays a vital role in building resilience among adolescent living with HIV, family support (Rajan, Navaneetham, and Sanjeeva 2022; Roberts et al. 2021; Wowolo et al. 2022) in relation to familial support parents act as gatekeepers of their child's healthcare, peer and community support; school connectedness (Sharp et al. 2018) and role modelling (Brown et al. 2021; Mburu et al. 2014) and healthcare support (Mutumba et al. 2015).

f.   Consequences

Resilience has positive effects on HIV therapy and the overall well-being of individuals with HIV. Including improved adherence to treatment(Vreeman et al. 2017), better psychosocial well-being (Betancourt et al. 2013), positive coping strategy(Sherr et al. 2018), better school performance and positive social relationship(Brown et al. 2021).

g.   Empirical references

Empirical references related to which approaches a concept can be objectively quantified or identified. Instrument for measuring or investigate resilience level of adolescent living with HIV must be valid and reliable. The scales of the resilience for ALHIV used in many research are Connor-Davidson Resilience Scale (CD-RISC)(Connor and Davidson 2003), Child and Youth Resilience Measure-28 (CYRM-28) (Liebenberg, Ungar, & van 2011), Resilience Scale for Adolescent (READ)(Hjemdal et al. 2006), Brief Resilience Scale (BRS) (Smith et al. 2008) and Adolescent Resilience Questionnaire (ARQ) (Gartland et al. 2011).

Several studies have taken advantage of questionnaire to assess resilience in adolescent living with HIV. Resilience was measured using the 10-item version of CD-RISC-10(Bhana et al. 2020; Kuo et al. 2019), CYRM-28 using to identify adolescents' complex needs and service usage (Kaunda-Khangamwa et al. 2020).

DISCUSSION

Defining resilience involves creating strategies to assist ALHIV face the challenges of their characteristics and illness. Resilience in ALHIV is linked to the availability of resources and positive behaviors that demonstrate optimistic attitudes. Access to resources from family, economic, social, environment, cultural and spiritual by addressing these factors through targeted interventions can help promote resilience and improve overall well-being in ALHIV (Kaunda-Khangamwa et al. 2020).

Characteristics of resilient individual refer to the conditions or traits of ALHIV who possess self-resilience. Individual resilience characteristics include positive attitude, positive internal cognition, self-assurances, personal faith, illness acceptance, high self-efficacy, self-esteem, emotional regulation and good personality traits are important factors. An ALHIV with strong resilience demonstrates personal belief such as confidence in destiny and acknowledgment of personal power as outcome of overcoming challenges, according to the findings.

Personal capacity encompasses skills such as coping strategies, problem-solving, HIV disclosure, readjustment, emotional regulation and managing stigma, exerting maximum effort in challenging situations and responding positively to adversity. With good emotional regulation can exhibited resilient individual by enabling them to cope with anxiety and depression (Chen et al. 2022). Conversely, patients with HIV can effectively manage their anxiety and depression levels by practicing emotional regulation, which is considered a personal capacity.

Social support resource plays a vital role in building resilience among ALHIV, in the form of lower HIV stigma, family support, peer and community support; school connectedness and healthcare support. Social support is related to coping skill that can improve resilience. Social support can help ALHIV maintain a positive outlook and can reduce the burden on ALHIV by provide practical assistance (Oktapia and Huwae 2023). By providing a safe space for open discussions and addressing stigma, support systems can help ALHIV develop resilience.

The consequences of resilience refer to the outcomes resulting from the development of resilience in ALHIV. Resilience and the outcome of HIV treatment are positively correlated

(Brown et al. 2021)Furthermore, resilience is directly associated with quality of life and psychological well-being. Resilience has major and autonomous role in an individual's bodily and psychological well-being. For ALHIV, resilience can improve the school performance, including improved attendance, higher grades and better performance on standardized tests. In the context of HIV treatment, resilience can help ALHIV cope with the challenges, which can positively impact their school performance (Kaunda-Khangamwa et al. 2020).

Several scales were utilized in the resilience measurement. Prior studies have indicated that a broad range of HIV resilience metrics is accessible in the literature on HIV research. Nonetheless, the stability, dependability and uniformity of the scale are crucial, as is the irregularity in the measurement of each study. CYRM-28, CD-RISC and ARQ. Analyzing the concept of resilience in ALHIV could be utilize in future research development. Research focused on enhancing the resilience of ALHIV during the construction process. Further research, could explore the causes and consequences of resilience to determine if the factors are correlated.

4.   CONCLUSION

Resilience is a multifaceted and complex concept. This study, using Walker and Avant's concept analysis paradigm, identified key attributes of resilience in adolescents living with HIV, including coping strategies, self-efficacy, positive adaptation, positive future expectations, and emotional regulation. Personal capacity and social support are crucial for positive adaptation during major adversity. Nurses can play a vital role in enhancing resilience among adolescents by facilitating treatment adherence, positive coping strategies, psychological well-being, academic performance, and relationships. Standardizing the conceptualization of resilience is essential for optimizing care strategies for adolescents living with HIV.

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R E S E A R C H　　　　　　　　　　　　　　　**Open Access**

The Relationship of Latrine Quality with The Incidence of Worms in The Mekarsari Health Center Area, Lebak District

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Abstract
Family latrines, crucial for sanitation, impact community health. In 2019, Banten had 70.5% latrine use, below the national 72.3%. Poor sanitation causes diseases like helminthiasis, affecting many, especially children. This study aims to determine the relationship between the quality of family latrines and the incidence of helminthiasis in the Mekarsari Health Center area of Lebak Regency. The study used a cross-sectional design. The population included all families with goose-neck latrines in the Mekarsari Health Center area, with a sample size of 88 families. Data analysis was conducted in stages using the chi-square test at an alpha level of 0.05. The results showed that nearly all respondents (93.2%) were male, 96.6% were of productive age, most had low education levels (67%), and nearly all were non-civil servants (97.7%). The majority (73.9%) had a monthly income below the Lebak Regency minimum wage (< Rp 2,944,665). There were still 17% of families with low-quality latrines, and 9.1% of family members suffered from or were infected with helminthiasis (Ancylostoma duodenale). The relationship test results showed a significant relationship between latrine quality and helminthiasis incidence, with a p-value of 0.000 (p<α). The OR value was 63,000, meaning that families with low-quality latrines were 63 times more likely to suffer from or be infected with helminthiasis compared to families with high-quality latrines. The conclusion is that there is a relationship between the quality of latrines and the incidence of helminthiasis in the Mekarsari Health Centre Area, Lebak Regency. Serious efforts are needed to empower families through health education and assistance to encourage them to improve, construct, and maintain quality latrines to prevent helminthiasis infections.

Keywords: Latrine Quality, Family Latrine, Helminthiasis.

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1. INTRODUCTION

Good sanitation is a crucial element supporting human health. The WHO defines sanitation as the provision of facilities and services for the disposal of human waste, such as urine and feces, and it also refers to maintaining hygienic conditions through waste management and wastewater treatment efforts (World Health Organization, 2019). Family latrines are an integral part of human waste disposal facilities. In 2019, 72.3% of families in Indonesia used permanent healthy latrines, while in Banten Province, the percentage was 70.5% (BPS Provinsi Banten, 2019).

Sanitation is closely linked to environmental health, which affects the overall health status of communities (Shrestha, et al., 2020; Holcomb, et al., 2020; Ferreira, 2021). Poor sanitation can negatively impact various aspects of life, including the quality of the living environment, contamination of drinking water sources, increased cases of diarrhea, and the emergence of several diseases. One of the diseases related to poor sanitation is helminthiasis (worm infection), a neglected tropical disease in Indonesia that can affect all ages but is more common in preschool and elementary school children. In 2014, the Central Bureau of Statistics recorded 932 cases of helminthiasis in West Sumba Regency (BPS Kabupaten Sumba Barat, 2014). This condition is alarming given the potential health impacts on families and communities.

Numerous efforts have been made by the government and the community to address this issue, but continuous effort and hard work are still needed. One approach to improving environmental quality, including enhancing human waste disposal facilities, is through community empowerment. Through community empowerment, it is hoped that people will increase their abilities, motivation, and participation in supporting welfare efforts by utilizing available community resources (Sukmawati, & Maryanti, 2022; Sabiq, Sulaiman, & Sugito, 2020).

This study aims to determine the relationship between the quality of family latrines and the incidence of helminthiasis in the Mekarsari Health Centre area of Lebak Regency. Given the conditions and impacts caused by the low quality of human waste disposal facilities (family latrines), it is necessary to conduct research and the results can be used by Puskesmas in empowering families and the Health Office in planning public health programs at the district/city level.

2. RESEARCH METHOD

This study is a cross-sectional design. The population in this study was all families who had family latrines (gooseneck) in the Mekarsari Health Centre area of Lebak Regency, with a sample size of 88 families. Data analysis was carried out in stages, namely, univariate analysis then bivariate analysis with a chi-square statistical test at alpha 0.05.

This study has received approval from the health research ethics committee of Semarang Health Polytechnic with number No. 0690/EA/KEPK/2023.

3. RESULTS AND DISCUSSION

Table 1. Distribution of Respondents' Characteristics by Age, Sex, Occupation, and Income in Mekarsari Health Centre Area, Lebak Regency

Characteristics	Frequency (f)	Percentage (%)
Age		
Elderly	3	3,4
Productive Age	85	96,6

Gender		
Male	82	93,2
Female	6	6,8
Education		
Low (< high school)	59	67,0
High (≤ high school)	29	33,0
Occupation		
Non-civil servant	86	97,7
Civil Servant	2	2,3
Income:		
< Lebak UMR (< IDR 2,944,665)	65	73,9
≥ Lebak UMR (≥ Rp.2,944,665)	23	26,1

Table 1 shows that the characteristics of respondents still found almost all respondents in the category of productive age, with almost all genders (93.2%) male. Most of them (67%) had low education (< SMA) with almost all of them (97.7%) working as non-civil servants, and most of them (73.9%) had monthly income below the minimum wage of Lebak Regency (< Rp. 2,944,665).

Table 2. Distribution of Respondents According to the Quality of Latrines and the Incidence of Helminths in the Mekarsari Health Centre Area, Lebak Regency

Variable	Frequency (f)	Percentage (%)
Quality of Family Latrines		
Not Qualified	15	17 %
Quality	73	83 %
Incidence of Diarrhoea		
Diarrhoea	12	13,6 %
No Diarrhoea	76	8 %
Incidence of Helminthiasis		
Worming	8	9,1 %
Not wormed	80	90,9 %

Table 2 shows that there are still 17% of families with unqualified latrines. Table 2 also shows that 9.1% of families still suffer from or are infected with helminthiasis (axylostoma duodenal).

Table 3. Distribution of Latrine Quality and Incidence of Helminths in Mekarsari Health Centre Area, Lebak District

Latrine Quality	Incidence of helminthiasis		Total	p-value	OR
	Helminthiasis	No Helminthiasis			
Not Qualified	7	8	15	0,000	63,00
	(46,7 %)	(53,3%)	(100,0 %)		
Qualified	1	72	73		
	(1,4 %)	(98,6 %)	(100,0 %)		
Total	8	80	88		
	(9,1 %)	(90,9 %)	(100,0)		

Table 3 shows that 46.7% of family members with helminthiasis were found in families with unqualified family latrines. The proportion was higher than that of families with good quality family latrines (1.4%). The results of the relationship test showed that there was a significant relationship between the quality of family latrines and the incidence of helminthiasis with a value of p = 0.000 (p < α). The OR value of 63.000 means that families with unqualified

latrines have a sixty-three times greater risk of suffering or being infected with helminthiasis compared to families with qualified latrines to suffer from helminthiasis.

DISCUSSION
Respondent Characteristics

The respondents' characteristics varied, and those in the productive age group played a crucial role in community health development, particularly in improving the quality of family latrines. Productive age families can enhance their latrines by ensuring adequate water supply, maintaining proper distance from clean water sources, and keeping latrines clean. Similarly, male heads of households can be instrumental in maintaining, repairing, and ensuring the upkeep of latrines to meet quality standards. Despite the majority (67%) of respondents having low education levels (less than high school), this should not hinder achieving quality latrines, as the technology involved is not complex. With consultation and technical assistance from health workers at the Puskesmas, achieving high-quality family latrines is feasible. Almost all respondents (97.7%) are employed in non-government sectors (laborers, private sector, entrepreneurs), with the majority (73.9%) earning below the minimum wage of Lebak District (Rp. 2,944,665). This economic challenge necessitates efficient management of income to meet health needs, including investing in sanitary facilities (Delaire, et al., 2020; Rasul, 2020; Andrés, Joseph & Rana, 2021; Anderson, 2021; Howard, 2021; Kulkarni, et al., 2022).

Despite the limitations, families can gradually allocate funds from their earnings to build and maintain quality latrines. Support and empowerment through health education and assistance are crucial in helping families achieve a healthy environment by ensuring quality family latrines.

Family Latrine Quality and Worm Incidence

The study found that 17% of families do not have high-quality latrines, lower than the 67.8% reported by Mukhlasin, Encep Nugraha, and Solihudin in Serang District (Mukhlasin, Nugraha, & Solihudin, 2020). Although the proportion is smaller, neglecting this issue can still impact community health and lead to conditions such as helminthiasis (Riaz et al., 2020; Farrant et al., 2020; Leta et al., 2020; Werkman et al., 2020; Kjetland, et al., 2020; Phillips, et al., 2022). The study reported that 9.1% of families were affected by helminthiasis, which is lower than the 11.1% infection rate found in a study of elementary school children in Jakarta. Similarly, the West Sumba District Statistics Bureau recorded 932 cases of helminthiasis in 2014 (BPS Kabupaten Sumba Barat, 2019). This situation is concerning and calls for efforts to prevent it from compromising the health of family members.

Relationship Between Latrine Quality and Helminthiasis Incidence

The study shows a significant relationship between family latrine quality and helminthiasis incidence (p-value = 0.000). Families with poor-quality latrines are sixty-three times more likely to suffer from or be infected with helminthiasis compared to those with high-quality latrines. Poor sanitation facilities, such as inadequate or poorly maintained latrines, facilitate environmental contamination with human feces, which are a major source of STH eggs and larvae (Mosler & Bamberg, 2017; WHO, 2018; Cairncross & Feachem, 2019; Okoyo, et al., 2020; Tadege et al., 2022; Binga, et al., 2022;). Their guidelines and frameworks provide a comprehensive approach to improving sanitation and reducing the global burden of helminthiasis (WHO, 2018; UNICEF, 2019; Nalbone, Giarratana, & Napoli. 2021; Lo et al., 2022; Wolf, et al., 2023). This finding highlights the importance of maintaining good latrine quality to significantly reduce helminthiasis incidence among family members. Therefore, it is

crucial to promote family empowerment in owning and maintaining quality latrines that meet health standards, as this can contribute significantly to reducing helminthiasis cases.

4. CONCLUSION

The conclusion is that there is a relationship between the quality of latrines and the incidence of helminthiasis in the Mekarsari Health Centre Area, Lebak Regency. Serious efforts are needed to empower families through health education and assistance to encourage them to improve, construct, and maintain quality latrines to prevent helminthiasis infections.

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R E S E A R C H   **Open Access**

Chemical and Physical Quality Biscuits Substitution Pumpkin and Leaves Katuk

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Abstract
Dependence on wheat flour is very high, so food diversification efforts need to be made to reduce this dependence. Biscuits are a product made from wheat flour as the main ingredient which has the potential to be developed using pumpkin and katuk leaves. The aim of this research was to determine the chemical and physical quality of biscuits substituted for pumpkin and katuk leaves. This research was an experimental study with a completely randomized design (CRD), consisting of 3 treatments and 1 standard treatment, with 3 repetitions of each treatment, so there were 12 treatment units. Chemical quality includes energy, carbohydrate content, protein, fat, Fe, calcium, vitamin C, β- carotene, and vitamin A. Physical quality is assessed using diameter, thickness, and spread ratio). Data were analyzed using *One Way Anova* and *Krusskal Tests Wallis*. The results of research on the chemical quality of biscuits show that there is a significant effect of the substitution of pumpkin and katuk leaves on the levels of protein, calcium, zinc, Fe, β- carotene, and vitamin C in biscuits. However, for energy, fat and carbohydrate levels decreased as the substitution of pumpkin and katuk leaves increased. The physical quality of biscuits substituted for pumpkin and katuk leaves shows that the diameter and thickness of the biscuits decrease as the percentage of substitutes for pumpkin and katuk leaves increases. This situation causes the value of the spread ratio (spread) is increase. The conclusion of this research is that there is a significant effect of the substitution of pumpkin and katuk leaves in biscuits on the chemical and physical quality of the biscuits.

Keywords: Biscuits, Leaves Katuk, Pumpkin Yellow.

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1. INTRODUCTION

The Indonesian government is currently continuing to promote the development of local food products to offset the influx of foreign products during the free market era. One of the food products developed is biscuits. Biscuits are a product that is quite popular with the public. The results of research on 1,500 adult consumers in Indonesia, and 500 housewives found that biscuits was the product most consumed (11%) compared to other products (Syana, 2017). Results Riskesdas (2013) about t h e consumption food from processing flour wheat states as much as 13.4% of Indonesia's population consumes biscuits ≥ 1 time per day.

Dependency to wheat flour very high, so effort diversification food need done forreduce such dependency and dig potency food other. Biscuits is product bakery dry Which made with method grilling dough made of fromflour wheat with or without the substitution, oil/fat, with or without the addition of foodstuffs and additional ingredients the food permitted (Badan Standardisasi Nasional, 2011). Potential local food For developed as a biscuit product is pumpkin yellow and katuk leaves.

Yellow pumpkin (Curcubita moschatai) is a type of creeping vegetable plant which is classified as an annual plant that immediately dies after bearing fruit. Pumpkin plants can grow in the lowlands and highlands with the ideal height being between 0-1500 meters above sea level (Pujimulyani, 2012). Yellow pumpkin contains carbohydrates which can reach 70% of the pumpkin puree making, so it has the potential to replace some of the use of wheat flour.

Katuk leaves (Sauropus androgynous) in Indonesia grows in the plains at an altitude of 2,100 meters above sea level. Katuk leaves are also rich in iron, provitamin A in formβ- carotene, vitamin C, and minerals. Table Composition Food Indonesia (TKPI) include that leaf cough own content proteins Which Enough tall compared to type vegetables other that is 6,4gr/100g ingredients.

The research results of Sariani, et al (2019) showed a very real effect on the organoleptic tests of sago biscuit products with the addition of katuk 6 leaf flour (Sariani, 2019). The research results of Suryati, et al (2019) show that the best treatment is the addition of puree pumpkin 53% and shell flour egg 7 % chicken affects ash content, calcium content and cookie texture (Suryati, Maherawati, 2019). The research results of Khoirunnisah, (2020) showed that 5% katuk leaf substitution in cookies was acceptable to panelists (Khoirunnisah, 2020).

This research aims to develop biscuits with the substitution of pumpkin and katuk leaves in a different form from biscuit products that have already been studied. Biscuits are substituted with pumpkin puree and fresh katuk leaves which are blanched and mashed. The development of this biscuit is to make it easier if it is carried out in the community because there is no need to make pumpkin flour and katuk leaf flour. Apart from that, this biscuit product can be an alternative for Posyandu cadres in providing local food-based PMT.

2. RESEARCH METHOD

Type of experimental research with completely randomized design (CRD), substitution factors for pumpkin puree (0%, 40%, 45%, 50%) and katuk leaves (0%, 3%, 4%, 5%) with 3 repetitions, So there are 12 treatment units. The ingredients for making biscuits are wheat flour (125 g, 100 g, 110 g, 120 g), tapioca (25 g), butter unsalted (30 g), egg yolk (8 g), powdered sugar (62.5 g), liquid milk (50 ml), pumpkin puree (0, 60 g, 67.5 g, 75 g), katuk leaves (0, 4.5 g, 6 g, 8 g), baking powder (2 g), salt (1.5 g) and vanilla (2 g).

The yellow pumpkin is cleaned, cut into pieces and steamed for 15 minutes and mashed until it becomes puree , then roasted at 70ºC for 20 minutes. Katuk leaves are washed and blanched for 2 minutes. Puree Yellow pumpkin, katuk leaves and liquid milk are mixed and blended for 3 minutes. Then mixed into the biscuit dough. Previously beat the egg yolks for 2 minutes, add powdered sugar, cake ammonia, salt and vanilla, mix well. Enter unsalted butter stir again. Then add the tapioca and pumpkin puree mixture, add the wheat flour and stir well until it forms a dough that can be rolled out with noodles maker. Mold the biscuits in a round shape and make a hole in the top. Bake the biscuits for 30 minutes at 130ºC . Then the biscuits are removed, cooled and packaged.

The chemical Quality (Nutrient Analysis). Biscuit nutritional analysis includes energy and protein using the micro method kejldhal, fat using the Shoxlet method, carbohydrates using the Luff method scroll, iron, calcium, zinc each using the Atomic method Absorption Spectrophotometry (AAS), vitamin C and vitamin A using spectrophotometry.

The physical quality of the biscuits was assessed by diameter and thickness parameters using a caliper (mm) and ratio distribution (spread ratio) which is the most important parameter for assessing the quality physical biscuits.

The data collected was each tested for data normality. If the data is normal, then a One Way Anova test is carried out with a confidence level of 95% and a further Duncan test. If it is not normal, then test with Krusskal Wallis with a confidence level of 95% and further Mann-Whitney test.

3.   RESULTS AND DISCUSSION

The results of the research show that the energy content of biscuits substituted for pumpkin and katuk leaves is on average in the range of 520.40 - 535.40 Kcal /100 g. The energy content of this biscuit decreased by 2.2% from F3 compared to F0.

Protein levels increased by 48.9% and the results of the *One-Way Test Anova* showed that there was a significant effect of substitution of pumpkin and katuk leaves in biscuits ($\rho=0.019$) on the protein content of biscuits. However, fat and carbohydrate levels have decreased (figure 1).
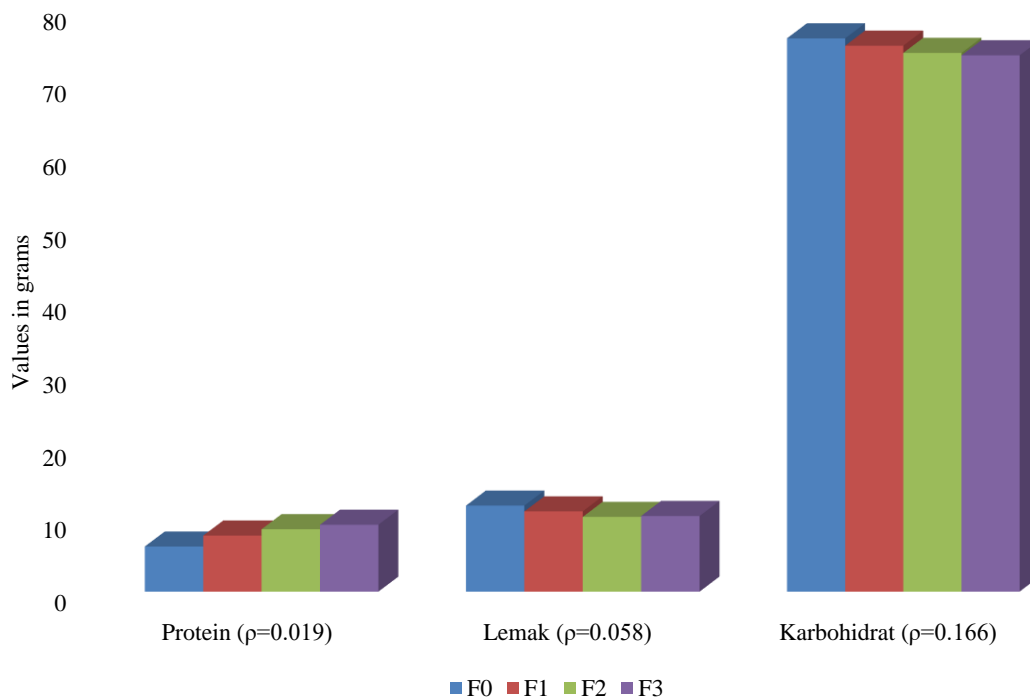

Figure 1. Macronutrient content of biscuits substituted for yellow pumpkin and katuk leaves

Micronutrient levels in biscuits substituted for pumpkin and katuk leaves showed an increasing trend in levels calcium, zinc, Fe, and β - carotene. However, vitamin A and vitamin C levels decreased.
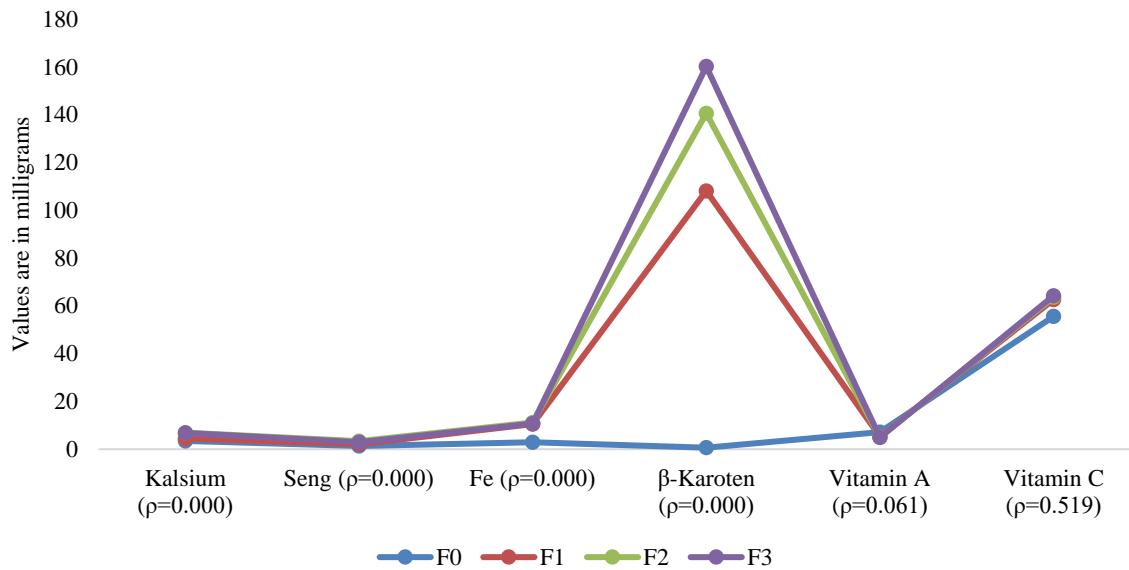
Figure 2. Nutrient Content of Micro Biscuits Substitute for Yellow Pumpkin and Katuk Leaves

The results showed that the physical quality of the biscuits changed in diameter, thickness and *spread ratio*, after being substituted with *pureed* yellow pumpkin and blanched katuk leaves *(*Table 1). The results of the *One Way-Anova test* show that there is no significant difference in substitution pumpkin and leaves cough on diameter ($\rho=0.053$), thickness ($\rho=0.077$) with *spreads ratio* ($\rho=0.280$) biscuits.

Table 1 . Physical Quality of Substitute Biscuits for Yellow Pumpkin and Katuk Leaves

Biscuit formula	Thickness (mm)	Diameter (mm)	*Spreads ratio*
F0	5.59±0.60 [a]	51.21±4.02 [a]	8.80±0.50 [a]
F1	4.75±0.80 [a]	46.76±2.33 [a]	9.54±1.51 [a]
F2	5.43±0.51 [a]	47.93±2.78 [a]	8.41±0.31 [a]
F3	4.93±0.40 [a]	47.13±1.74 [a]	10.05±1.25 [a]

Source: Primary Data, 2023
Description: The value displayed is the average ± standard deviation. The average value in the same column with a letter different
shows difference significant $\rho < 0.05$

DISCUSSION
Chemical Quality

Energized contained from something product determined from content energy material its compiler. Energy on substitute biscuits pumpkin and leaves katuk experienced a decrease of 2.2% in F3 compared to F0, as the substitution of pumpkin increased. This is because the energy from the wheat flour in the original biscuits will be replaced with less energy from pumpkin (51 Cal/100 g) compared to the energy from wheat flour (333 Cal/100 g) according to the 2017 Indonesian food composition table. *One-Way* Test results *Anova* for biscuit energy, substitution of pumpkin and katuk leaves proved to have no significant effect ($\rho=0.189$) towards the substitution of pumpkin and katuk leaves in biscuits in the three existing formulas.

The energy of biscuits is influenced by the amount of macronutrients contained in the ingredients for making biscuits, such as carbohydrates, fat, and protein. The results of this research show that the energy content of biscuits has exceeded the SNI No. standard. 01-2973-1992, namely a minimum of 400 Cal/100 g biscuits. In line with the research by Roifah, Razak, and Suwita (2019) , it shows that the energy value of biscuits substituted for green bean flour and tuna fish flour for PMT for pregnant women has decreased (Roifah et al., 2019). The research results of Latifah, Rahmawaty, and Rauf (2019) show that there is no effect of tempeh flour substitution on the energy value of arrowroot flour biscuits.

The increase in protein content in biscuits substituted with pumpkin and katuk leaves compared to original biscuits occurred due to the substitution of katuk leaves and the use of milk. Katuk leaves have a protein content of 6.4 g/100 g and this protein content is significantly contributed to the biscuits substituted with katuk leaves in accordance with the 2017 Indonesian food composition table. The protein content in these biscuits is in accordance with SNI 2973:2011 concerning biscuits, which requires a minimum protein content in biscuits of 5%. As research by Sariani (2019) shows the same thing, namely the protein content of selected biscuits is K1 k because the addition of katuk leaf flour in making sago biscuits, can increase the protein content in sago biscuits (Sariani, 2019).

The fat and carbohydrate content in the substitute biscuits for pumpkin and katuk leaves is in the range of 10.40 g/100 g to 11.83 g/100 g and this fat content decreases when compared with the original biscuits (Figure 1). *One-way* test results *Anova* also shows There is no significant effect on the fat and carbohydrate content of biscuits rate fat ($\rho=0.058$) and carbohydrates ($\rho=0.166$). The low fat content in biscuits substituted for pumpkin and katuk leaves is caused by the fat content in pumpkin (0.5 g/100 g) being less than in wheat flour (1.0 g/100 g). Likewise with levels carbohydrates in yellow pumpkin are lower If compared to levels of carbohydrates in flour wheat. Research by Saputri , et al ., (2021) proves that levels of carbohydrate product influenced by type materials used ie Substituted carrots for fish pempek have rate lower carbohydrates compared to pempek control (Saputri, Hidayah, & Muttalib, 2021). The results of this research are in line with research by Ambarwati (2020), which shows that the more substitutions there are for pumpkin flour and banana flour, the lower the fat content of *the cookies* (Ambarwati, 2020). The research results of Saputra, Ibrahim, and Faradilla, 2018 , also showed the same thing, namely the highest average carbohydrate content of *cookies* in treatment A (100% wheat flour) with an average carbohydrate content of 70.19% and the lowest in treatment B (80% rice bran flour: corn flour 20%) with an average carbohydrate content of 54.73%.

The calcium levels in the biscuits showed that there was a significant effect ($\rho=0.000$) of the substitution of pumpkin and katuk leaves on the calcium levels of the biscuits. This is caused by the high levels of calcium in katuk leaves, namely 233 mg /100 g. In line with research by Suhartini et al . 2018 , stated that the addition of Moringa leaf flour increased the calcium value of tempeh formula biscuits with the addition of 9% Moringa leaf flour (13.5 g), namely 38.297 mg, when compared with 21.356 mg without the addition of Moringa flour. Study Lestari, et al., (2020) stated Calcium levels in cookies with substitution of katuk leaves and oatmeal (120 mg) increased compared to cookies without substitution (91 mg) .

Zinc levels in biscuits increase and are present substitution Yellow pumpkin and katuk leaves apparently have an effect to rate zinc in biscuits (Figure 2). The increase in zinc levels in biscuits is caused by the zinc levels contained in the biscuit ingredients, namely wheat flour, butter, milk, egg yolk, pumpkin and katuk leaves. In line with the research by Mumpuni and Khasanah, (2021) which states that the greater the proportion of haruan fish meal and pumpkin seed flour, the greater the zinc content in the biscuits (Mumpuni & Khasanah, 2021). The zinc content in biscuit products is also influenced by the *cookie baking process* (Mileiva, Palupi, & Kusnandar, 2017). Biscuits substituted for pumpkin and katuk leaves were baked at 120ºC for ±27 minutes and this process also affected the zinc content of the biscuits which increased as the substitution for pumpkin and katuk leaves increased.

Fe content in the biscuits is clearly visible in Figure 2 , Fe increases to 272.8% when seen from the original biscuits. The results of the analysis also show that there is a significant effect of substitution of pumpkin and katuk leaves in biscuits ($\rho=0.000$) on the Fe content of biscuit products. Increased Fe levels This biscuit is caused by the contribution of Fe levels in katuk leaves , namely as much as 3.5 mg /100 g of material. Putri Research, et al . (2021) stated that the iron content of katuk leaf *cookies is 1,308* mg /100g (Putri, Almasyhuri, & Mirani, 2021). Likewise, research by Lestari, et al (2020) shows the average value of iron *in cookies* with the substitution of katuk leaves and oatmeal at a concentration of 0%:0%, namely 0.12 mg, and a concentration of 5%:5%, namely 0.14 mg (Lestari, 2020). Other similar research results showed that there were significant differences in iron levels in each treatment formulation of haruan fish flour biscuits, pumpkin seed flour, and pumpkin fruit flour (p=0.001). (Mumpuni & Khasanah, 2021).

Beta-carotene (β- carotene) is an organic compound and is classified as a terpenoid and is the most active provitamin A found in plant foods. Foods containing beta-carotene can increase the body's

immunity, because of the antioxidant properties contained in beta-carotene (Parwata, Ratnayani, & Listya, 2010). Meanwhile, vitamin A is only found in animal tissue and not in plants. However, many plants contain the pigment carotene which can be converted into vitamin A in the body. Therefore, carotene is called pro-vitamin A because it can be converted into vitamin A (Sanif & Nurwany, 2017). The results showed that the levels of β- carotene and vitamin A were inversely related. β- carotene levels increased with increasing presentation of yellow pumpkin and katuk leaf substitutions, whereas vitamin A levels decreased with increasing substitution of yellow pumpkin and katuk leaves. If seen from the *one-way* test results *Anova*, then There is a significant effect of substitution of pumpkin and katuk leaves in biscuits (ρ=0.000) on β- carotene levels biscuit products. On the other hand, there was no significant effect of substitution of pumpkin and katuk leaves in biscuits (ρ=0.061) on the vitamin A levels of biscuit products. The ingredients used in making these biscuits are very influential in contributing to the vitamin A and β- carotene content in biscuit products. This also happened in Kusumawardani et al ., (2018) which showed that increasing the amount of composite flour causes the vitamin A content in biscuits to increase along with increasing the amount of composite flour, which uses banana flour with a high vitamin A content (Kusumawardani et al., 2018).

Substitution of pumpkin and katuk leaves in the biscuits had no effect real (ρ=0.519) against Vitamin C levels in biscuits. This is due to the easy nature of vitamin C Water soluble, though Vitamin C levels in yellow pumpkin (2 mg /100 g) and katuk leaves (164 mg /100 g) are quite high(RI, 2017). Apart from that, vitamin C is a vitamin that is not heat resistant. In line with research by Yudhistira B, Sari TR, Affandi (2019) which states that the process of roasting and crushing spinach and tomatoes with a blender is a factor that causes vitamin C levels in *cookies* to decrease (Yudhistira, Sari, & Affandi, 2019).

Quality Physique

Quality physique from biscuits substitution pumpkin and leaves cough show exists change characteristic physique biscuits seen from average size diameter, thickness and ratio spread (*spread ratio*). The diameter and thickness of the biscuit pieces decreased with increasing substitution of pumpkin and katuk leaves. Baljeet, Ritika, and Roshan (2010) stated that the diameter and thickness of biscuits are two parameters that always move in opposite directions (Baljeet et al., 2010).

Spread ratio (*spread ratio*) is the most important parameter for assessing biscuit quality (Bose & Shams-Ud-Din, 2010). *Spreads The ratio* is calculated by dividing the diameter by the thickness of the biscuit. Thicker biscuits will have *spread lower ratio* compared to thinner biscuits, provided that the diameter of the biscuits is not significantly different. If the diameter of the biscuits differs significantly, then the thicker biscuit has *a spread* higher *ratio.* Nonetheless, biscuits with *spread The high ratio* in F1 (9.54) was apparently more accepted by the panelists. Research by Hussein *et al* ., (2011) and stated that *cookies* that have a higher spread ratio are considered the most desirable or most acceptable. Eissa, Hussein, and Mostafa, 2007 and Niaba, et. al ., 2013 also said that biscuits with *spread value A high ratio* is best.

Biscuits in this study were substituted with yellow pumpkin in *puree form* and katuk leaves which had been blanched *and* crushed (blended). The replacement of wheat flour with pumpkin and katuk leaves causes the diameter and thickness of the biscuits to decrease as the percentage of substitution for pumpkin and katuk leaves in the biscuit dough increases. This condition is what causes the *spread value The ratio* increases further, as a result of using pumpkin *puree and crushed katuk leaves which still* contain water. This is in accordance with the results of the analysis show The percentage of water content in biscuits substituted for pumpkin and katuk leaves is between 3.48% -9.58% .

The physical quality of biscuits substituted with pumpkin and katuk leaves is indeed different from biscuits substituted with other composite flours. This is caused by the substitution of pumpkin *puree* in the form of paste and katuk leaves which are blended in a crushed form, not in the form of flour, so it has a lower swelling power compared to composite flour or other flours. Apart from that, the amount of gluten in the dough decreases with the increasing number of substitutions of pumpkin *puree* and crushed katuk leaves, which causes interaction between water and gluten to form a gluten network so that it can withstand gases that expand during the baking process. This is different from the results of research by Pratama, Mitha, and Nendra (2017), which found that the addition of banana flour had

no real effect on the diameter, thickness and volume of cookie expansion (Pratama, Mitha & Nendra, 2017).

4.   CONCLUSION

Biscuits substitution pumpkin and leaves cough reviewed from quality chemical and physical, in part big nutrition and size show exists enhancement quality, if compared to original biscuits. For further research, it is recommended to carry out shelf life tests on biscuit products so that the safety of biscuit products can be guaranteed and to test the effect of giving substitute biscuits for pumpkin and katuk leaves to pregnant women.

ACKNOWLEDGEMENTS

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