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Active and receptive arts participation and their association with mortality among adults in the United States: a longitudinal cohort study

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ABSTRACT

Objectives: The aim of the study was to explore associations between active and receptive arts participation and all-cause mortality among adults in the United States population.
Study design: This was a prospective cohort study.
Methods: Data were derived from the Health and Retirement Study. Separate Cox proportional hazards models were constructed for two cohorts (2012 and 2014) to examine associations between arts participation and mortality.
Results: Independent of sociodemographic and health factors, participants aged ≥65 years had a higher mortality risk if they did not engage in music listening, hazard ratio (HR) 1.39 (95% confidence interval [CI]: 1.12–1.71); singing/playing an instrument, HR 1.49 (95% CI: 1.07–2.0); or doing arts and crafts, HR 1.39 (95% CI: 1.00–1.92). For participants aged <65 years, there was a higher mortality risk if they did not listen to music, HR 1.79 (95% CI: 1.07–3.01). Older participants from the 2014 cohort had a higher mortality risk if they did not engage in active arts, HR 1.73 (95% CI: 1.08–2.77).
Conclusions: Engagement in the arts was associated with lower risk of mortality even after risk adjustment, especially for adults aged ≥65 years. Greater access and integration of arts in everyday life is recommended.

Introduction

Arts engagement can span from the experience of music and art in everyday life to the use of music therapy and art therapy for clinical outcomes. Regardless of the type of engagement, one commonality is the individual's relationship with the arts, central to which is access and participation. Research literature has reflected positive outcomes from creative arts therapies with clinical populations. For example, elderly nursing home residents showed reduced depressive symptoms following a 10-week intervention of group music therapy.[1] And a systematic review of Art Therapy and Music Therapy for breast cancer patients showed a reduction of negative emotional states, reduced anxiety, and improvements in quality of life.[2] Engagement in the arts outside of therapy may also increase well-being in the general population.[3] Large population studies, primarily from Europe, have examined associations between the arts and health, finding positive outcomes from cultural participation and active engagement with the creative arts.[4–8] Fancourt and Steptoe studied a cohort of 6710 older adults from the United Kingdom and found a protective association between attending arts events and mortality over a 14-year period.[7] Similarly, Swedish studies found an association between attending cultural events and mortality[6] but failed to show a relationship

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between active arts participation and mortality.[9] Arts epidemiology studies are rare in the United States and have focused on the effects of receptive arts participation, such as attendance of cultural events[10] and music listening,[11] rather than the effects of active engagement (e.g., singing).

To date, there have been no published epidemiological reports from the United States that address associations between arts participation and mortality. The aim of this study was to examine that association among a representative US sample. The hypotheses were that (1) participation in the arts will be associated with improved survival after adjustment for sociodemographic and health factors and (2) the relationship between active arts participation (e.g., making music) and survival will be more robust than the relationship between receptive arts experiences (e.g., attending cultural events) and survival.

Methods

The Health and Retirement Study (HRS) is a longitudinal panel survey that follows a representative of Americans over the age of 50 years, and their spouses of any age, into retirement to answer questions related to aging.[12] Core data are collected biennially through in-person or telephone interviews and internet surveys. In addition to demographics, questions about changing health, economics, and social structures are collected. A Consumption and Activities Mail Survey (CAMS), distributed on the off years from the core data, includes questions related to time use, including arts participation. Special topic modules, such as the Culture and the Arts Module used in this study, are also sent to a random subsample of respondents and collected with the core data. For this analysis, two samples were taken from data spanning 2012–2016, forming two groups that are referred to as the 2012 and 2014 cohorts.

Eligible participants for the 2012 cohort completed the 2012 HRS and the 2013 CAMS. Demographics and baseline health characteristics were obtained from the 2012 HRS and arts participation from the 2013 CAMS. The 2014 cohort completed the Culture and the Arts Module included with the 2014 biennial core interview. The module gathered nuanced information related to active arts engagement. Baseline characteristics were taken from the 2014 HRS core data. Participants from both cohorts were followed through 2016. To examine differences that may occur in older adults who are passed the typical US age of retirement, cohorts were stratified by age <65 years and ≥65 years.

Measures

The four arts variables included receptive (attending cultural events and listening to music) and active (singing or playing an instrument and doing arts and crafts) arts participation. Cultural events included concerts, movies, lectures, or attending museums. Participants were asked about activity during the last week for music listening and the last month for all other arts variables. Responses were dichotomized into no or yes to reflect responses of no participation or any participation. Active arts participation was examined for the 2014 cohort and dichotomized into no or yes responses for engagement in any of the following active arts categories: painting, sculpting, pottery, or ceramics, singing or playing an instrument, acting in theater or film, creative writing, and handwork crafts (weaving, crochet, knitting, jewelry, leatherwork, woodwork, metalwork).

Demographic and socio-economic covariates included age, gender, race/ethnicity, and educational attainment. Health and behavioral covariates included self-reported health, number of chronic conditions, dementia, history of smoking, and physical activity.

The primary outcome was all-cause mortality. The date of death was extracted from the HRS file, and time to death was calculated from the baseline date for each cohort (2012 or 2014) to the date of death.

Statistical analysis

Baseline characteristics were summarized for each cohort and compared between the two age groups. Baseline characteristics were also examined by arts participation. The means and standard deviations (SDs) were presented for continuous variables and compared using *t*-tests. Frequency and percentages were presented for categorical variables and compared using chi-square or Fisher's exact tests. The Kaplan–Meier method was used to estimate the survival function. Cox proportional hazards models were built to generate unadjusted and adjusted hazard ratios (HRs) and 95% confidence intervals (CIs) to evaluate associations of arts variables and mortality. Baseline characteristics included in the adjusted model were selected on the basis of *a priori* clinical judgment and by examining the bivariate relationships ($P < 0.1$). Separate Cox models were constructed for both age groups and for each of the five arts variables. Participants who dropped out of the study or who were still alive in 2016 were censored. All analyses were conducted in SAS Version 9.4 2016 (Cary, NC).

Results

Baseline characteristics

The 7301 participants comprised individuals >50 years of age and their spouses of any age. There were 5805 participants in the 2012 cohort with a median age of 66 years and a range of 27–102 years. The 2014 cohort was comprised of 1496 participants, median age of 66 years with a range of 30–98 years. The baseline characteristics of both cohorts are presented in Table 1. Most participants were White. Approximately 50% of participants had some college-level education. Those aged <65 years were more likely to be working part time or full time and to have a higher household income. More than 71% of participants reported being in excellent, very good, or good health, with greater than 83% stating no difficulties with activities of daily living (ADLs). There were significant differences by age group for number of ADLs and chronic conditions. In both cohorts, approximately 62% of participants were engaging in physical activity at least once per week but less than every day.

Engagement in the arts

Younger participants were more likely to listen to music (86.9% vs 71.3%; $P < 0.001$), attend cultural events (27.5% vs 23.4%; $P < 0.001$), or sing or play an instrument (21.5% vs 24.5%; $P < 0.001$). Younger and older cohort members were similar in terms of arts and crafts participation (19.9% vs 20.2%; $P = 0.805$) and active art-making (52.2% versus 50.2%; $P = 0.450$). Arts participation by race and ethnicity, education level, and income are presented in Supplemental Table 2. Engagement differed by race with Black participants more likely than White participants to listen to music and to sing or play an instrument. All areas of arts participation and engagement were higher for participants with some college education vs participants with less education. Cultural event attendance and music listening were higher for participants with high income compared with those with middle or low income.

Table 1
Baseline characteristic percentages and frequencies of 2012 and 2014 cohort stratified by age.

Characteristic	2012 cohort				2014 cohort			
	Whole cohort (N = 5805)	Age < 65 years (N = 2694)	Age ≥ 65 years (N = 3111)	*P* value	Whole cohort (N = 1496)	Age < 65 years (N = 680)	Age ≥65 years (N = 816)	*P* value
	N (%)	N (%)	N (%)		N (%)	N (%)	N (%)	
Age (years), mean (SD)	66.9 (11.0)	57.0 (4.9)	75.4 (6.9)	<0.001	67.5 (11.2)	57.6 (5.1)	75.8 (7.4)	<0.001
Gender								
Male	2362 (40.7%)	1068 (39.6%)	1294 (41.6%)	0.131	578 (38.6%)	261 (38.4%)	317 (38.8%)	0.854
Female	3443 (59.3%)	1626 (60.4%)	1817 (58.4%)		918 (61.4%)	419 (61.6%)	499 (61.2%)	.
Race/ethnicity								
Hispanic	665 (11.5%)	426 (15.8%)	239 (7.7%)	<0.001	196 (13.1%)	123 (18.1%)	73 (8.9%)	<0.001
White	3959 (68.2%)	1516 (56.3%)	2443 (78.5%)		952 (63.6%)	353 (51.9%)	599 (73.4%)	.
Black	1005 (17.3%)	646 (24.0%)	359 (11.5%)		298 (19.9%)	173 (25.4%)	125 (15.3%)	.
Other	175 (3.0%)	105 (3.9%)	70 (2.3%)		50 (3.3%)	31 (4.6%)	19 (2.3%)	.
Education								
Some high-school/GED	2930 (50.5%)	1192 (44.2%)	1738 (55.9%)	<0.001	734 (49.1%)	294 (43.2%)	440 (53.9%)	<0.001
Some college and above	2875 (49.5%)	1502 (55.8%)	1373 (44.1%)		762 (50.9%)	386 (56.8%)	376 (46.1%)	.
Marital status								
Married/partnered	3818 (65.8%)	1897 (70.4%)	1921 (61.8%)	<0.001	914 (61.1%)	456 (67.1%)	458 (56.2%)	<0.001
Divorced/separated	759 (13.1%)	449 (16.7%)	310 (10.0%)		237 (15.9%)	150 (22.1%)	87 (10.7%)	.
Widowed	925 (15.9%)	139 (5.2%)	786 (25.3%)		282 (18.9%)	34 (5.0%)	248 (30.4%)	.
Never married	301 (5.2%)	209 (7.8%)	92 (3.0%)		62 (4.1%)	40 (5.9%)	22 (2.7%)	.
Employment status								
Full time	1439 (25.8%)	1247 (48.3%)	192 (6.4%)	<0.001	375 (26.3%)	330 (51.9%)	45 (5.7%)	<0.001
Part time	806 (14.4%)	434 (16.8%)	372 (12.4%)		192 (13.4%)	103 (16.2%)	89 (11.2%)	.
Retired	3039 (54.5%)	645 (25.0%)	2394 (79.9%)		801 (56.1%)	153 (24.1%)	648 (81.8%)	.
Unemployed or disabled	296 (5.3%)	256 (9.9%)	40 (1.3%)	.	60 (4.2%)	50 (7.9%)	10 (1.3%)	.
Household income, mean (SD)	67514.9 (94684.6)	81510.9 (110111.9)	55394.9 (76912.9)	<0.001	73964.3 (158768.8)	86534.9 (199085.7)	63488.9 (113915.3)	0.005
Self-reported health								.
Excellent/very good/good	4305 (74.2%)	1995 (74.1%)	2310 (74.3%)	0.833	1070 (71.6%)	498 (73.3%)	572 (70.1%)	0.166
Fair/poor	1496 (25.8%)	698 (25.9%)	798 (25.7%)		425 (28.4%)	181 (26.7%)	244 (29.9%)	.
ADLs								
No difficulty	4921 (84.8%)	2327 (86.4%)	2594 (83.4%)	0.006	1249 (83.5%)	588 (86.5%)	661 (81.0%)	0.004
1–2 difficulties	646 (11.1%)	271 (10.1%)	375 (12.1%)		183 (12.2%)	62 (9.1%)	121 (14.8%)	.
≥3 difficulties	238 (4.1%)	96 (3.6%)	142 (4.6%)		64 (4.3%)	30 (4.4%)	34 (4.2%)	.
Dementia, yes	103 (1.8%)	33 (1.2%)	70 (2.3%)	0.002	19 (1.3%)	6 (0.9%)	13 (1.6%)	0.217
Sum of chronic conditions, mean (SD)	2.1 (1.5)	1.7 (1.4)	2.5 (1.4)	<0.001	2.3 (1.5)	1.8 (1.5)	2.6 (1.5)	<0.001
Ever smoke, yes	3280 (56.8%)	1520 (56.6%)	1760 (57.1%)	0.714	805 (54.0%)	370 (54.4%)	435 (53.6%)	0.765
Physical activity								
Never or <1× week	1693 (29.2%)	669 (24.8%)	1024 (32.9%)	<0.001	439 (29.3%)	171 (25.1%)	268 (32.8%)	0.002
At least 1× week	3594 (61.9%)	1810 (67.2%)	1784 (57.3%)		920 (61.5%)	451 (66.3%)	469 (57.5%)	.
Every day	518 (8.9%)	215 (8.0%)	303 (9.7%)		137 (9.2%)	58 (8.5%)	79 (9.7%)	.
Active arts	.	.	.	.	764 (51.1%)	355 (52.2%)	409 (50.2%)	0.450
Listen to music	4473 (78.5%)	2300 (86.9%)	2173 (71.3%)	<0.001	.	.	.	.
Attends cultural events	1452 (25.3%)	735 (27.5%)	717 (23.4%)	<0.001	.	.	.	.
Sing/play instrument	1228 (21.5%)	652 (24.5%)	576 (18.9%)	<0.001	.	.	.	.
Arts and crafts	1146 (20.0%)	530 (19.9%)	616 (20.2%)	0.805	.	.	.	.

SD, standard deviation; ADLs, activities of daily living.

Multivariable modeling of mortality

The estimated HRs for the association between demographic, health, arts variables, and all-cause mortality are provided in Supplemental Table 1. Male sex and greater number of chronic conditions were associated with increased risk of mortality. Better self-reported health at baseline was associated with lower risk of mortality. For older participants, the risk of mortality was higher with

Table 2
Multivariable modeling: arts variables and predictors of mortality.

	Unadjusted model				Adjusted model			
	Age <65 years HR (95% CI)	*P* value	Age ≥65 years, HR (95% CI)	*P* value	Age <65 years, HR (95% CI)	*P* value	Age ≥65 years HR (95% CI)	*P* value
Listen to music (no vs yes)	2.51 (1.52, 4.15)	<0.001	2.11 (1.73, 2.57)	<0.001	1.79 (1.07, 3.01)	0.027	1.39 (1.12, 1.71)	0.003
Attend cultural event (no vs yes)	1.74 (0.97, 3.10)	0.062	2.06 (1.54, 2.76)	<0.001	0.99 (0.54, 1.82)	0.975	1.16 (0.85, 1.58)	0.361
Sing/play instrument (no vs yes)	1.23 (0.71, 2.14)	0.455	1.84 (1.36, 2.51)	<0.001	0.99 (0.57, 1.74)	0.979	1.49 (1.07, 2.07)	0.019
Arts and crafts (no vs yes)	1.22 (0.67, 2.22)	0.513	1.95 (1.44, 2.66)	<0.001	0.81 (0.44, 1.51)	0.513	1.39 (1.00, 1.92)	0.049
Active arts[a] (no vs yes)	1.27 (0.46, 3.50)	0.648	1.89 (1.21, 2.95)	0.005	1.11 (0.38, 3.21)	0.919	1.73 (1.08, 2.77)	0.025

HR, hazard ratio; CI, confidence interval.

[a] Active arts included any participation in: painting, sculpting, pottery, or ceramics, singing or playing an instrument, acting in theater or film, creative writing, and handwork crafts.

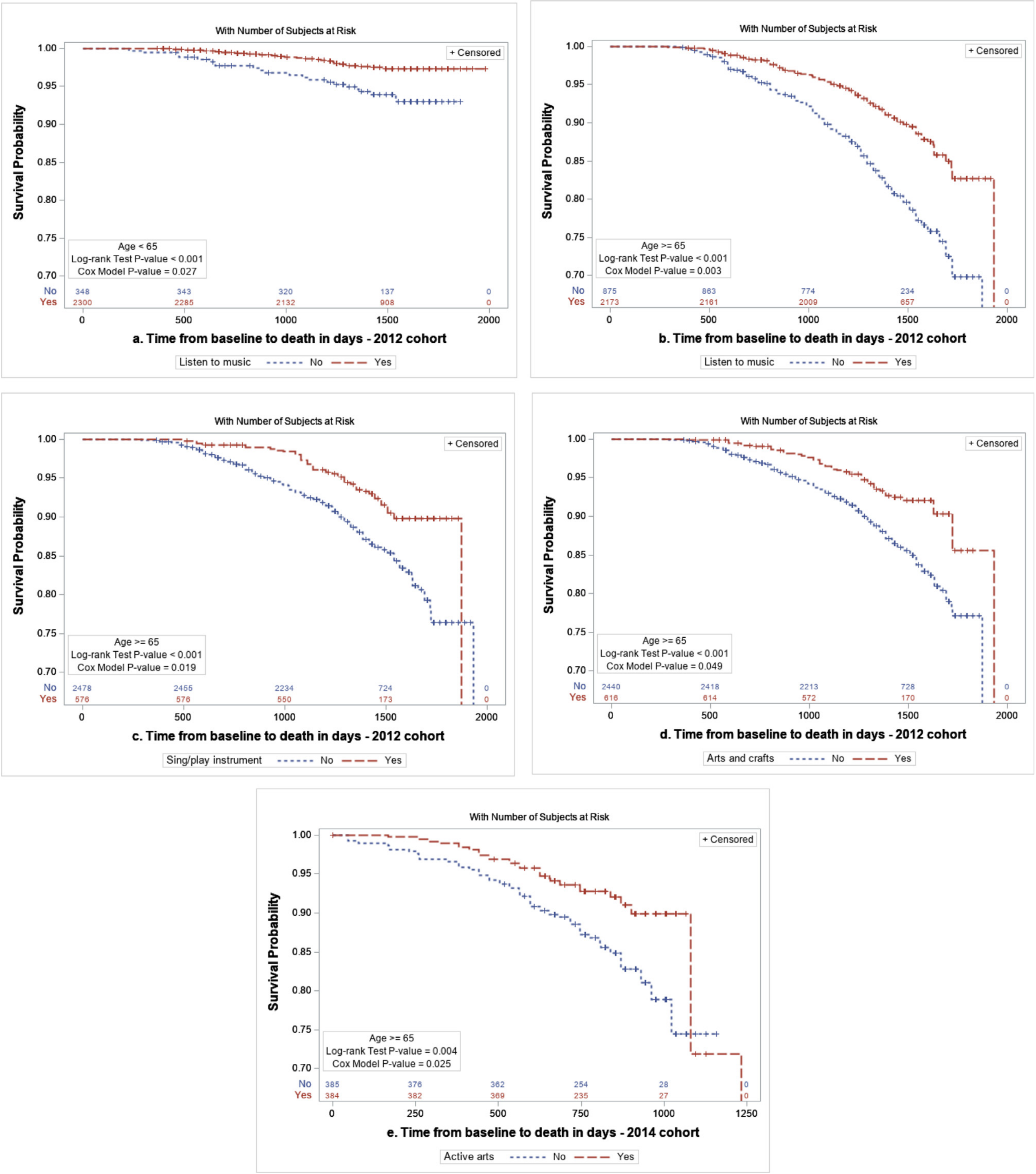

Fig. 1. Kaplan–Meier plots for mortality, which show survival probability by type of arts engagement, stratified by age and adjusted for confounders.

increasing age, lower education attainment, less physical activity, and dementia. There was a decreased risk of mortality for younger participants who identified as Hispanic compared with younger participants who identified as White, Black, or other. Among the 2014 cohort, those who never exercised or exercised less than once per week had a higher mortality risk than those who exercised at least once per week. There was a lower mortality risk for older participants who never smoked and for those with fewer chronic conditions.

Unadjusted and adjusted associations between arts variables and mortality are provided in Table 2. In the unadjusted model, not listening to music was associated with a higher mortality risk among both younger and older participants. The unadjusted mortality risk was also approximately twofold higher for older participants who did not attend cultural events, did not sing or play an instrument, and did not engage in arts and crafts. After adjustments for baseline characteristics, non-music listeners had a higher mortality risk than those who listened to music: HR 1.79 (95% CI: 1.07–3.01) for those aged <65 years and HR 1.39 (95% CI: 1.12–1.71) for those aged ≥65 years. For older participants, there was also increased mortality risk for those who did not sing or play an instrument, HR 1.49 (95% CI: 1.07–2.0), and those who did not engage in arts and crafts, HR 1.39 (95% CI: 1.00–1.92). Older participants who did not engage in any active arts had a higher mortality risk than those who did engage in active arts, HR 1.73 (95% CI: 1.08–2.77). Kaplan–Meier plots in Fig. 1 and Supplemental Fig. 1 illustrate the survival probability and time from baseline to death: these plots demonstrate that the survival curves split relatively early after baseline for cohort participants who engaged in active art-making versus those who did not.

Discussion

This study explored associations between arts participation and survival among a representative sample of US adults. An analysis of the longitudinal relationship between arts participation and all-cause mortality demonstrated better survival rates with specific types of arts participation across age groups. Decreased mortality risk was associated with adults who listen to music. For older adults, singing or playing an instrument and participating in arts and crafts were also associated with decreased mortality risk. For older adults, engaging in any type of active arts was associated with a decreased mortality risk.

As hypothesized, the association between *active* arts engagement and survival was robust, particularly for older participants. One explanation may be that in addition to a high level of focus and engagement, mastery and social interaction are often present in active arts activities and are identified factors that benefit older adults.[13] Playing in a community band, for instance, requires reaching a certain skill level on an instrument and interacting with others musically to produce a cohesive sound that is aesthetically pleasing. Older adults who experience social isolation have a higher mortality risk,[14–18] but active arts participation provides opportunity for social interaction and can reduce feelings of loneliness,[19] thereby mitigating some challenges of aging.

Unanticipated study results included the strong association between music listening and survival. In this cohort, music listening was the only arts activity that was significantly associated with mortality risk for younger participants. Music listening in the clinic and in everyday life has demonstrated effects on psychological and physiological responses.[20] For instance, Linnemann et al. found that listening to relaxing music decreased subjective stress levels and cortisol concentrations in healthy adults.[21] Ethnographic studies have detailed the health benefits of using self-selected music for adults with long-term illness.[22,23] DeNora maintains that music is implicated in social agency and may shape how individuals present themselves, feel about themselves, and interact with others.[24] Although seemingly a passive and solitary activity, listening to music can facilitate empathy and be an agent for cultural understanding, forging connections with cultures that are different from one's own.[25] This has implications for feelings of social connectedness, which is especially challenged during times of increased isolation, whether from issues connected to aging or from imposed isolation during times of pandemic.

This study builds on previous results that found positive outcomes associated with active arts participation[4,5] but differs from epidemiological studies that demonstrated health benefits from attendance of cultural events.[6,7,10,26] Among participants in this study representative of the US population, no evidence was found to support an association between attending events and better survival. One possible explanation may be that participants in this study were primarily >50 years of age, but aside from Fancourt et al.,[7] other studies included all participants over the age of 15 years.[9,26] Perhaps, health benefits from attending cultural events are greater when participation, and one's relationship to the arts, begins at a younger age. Another explanation for dissimilar findings may be cultural differences in importance and value placed on attendance. For instance, in Nordic countries where there is an emphasis on arts participation through programs such as 'arts on prescription' or 'social prescribing,'[27] the rates of cultural attendance are >80%,[28] compared with 54% in the United States.[29] Social prescribing programs prioritize access to the arts as an integral part of communities and uphold arts engagement as a social determinant of health. There is great value placed on the arts when participation is seen as a vehicle to engage marginalized groups, promote well-being, and prevent premature mortality.[30]

A strength of this study was its large longitudinal cohort representative of the US population. Data included comprehensive sociodemographic and health information and multiple variables related to active and receptive arts participation. This study provides new perspective on arts participation and public health in the US population, building support for greater inclusion of the arts in everyday life, particularly among older adults. The main limitation is that this was a cross-sectional assessment. Because the questions were based on participation during a specific time, it is unknown how that may have changed over time, and not possible to determine the cause–effect relationships. The data were limited in terms of quality of engagement. Details about genre of music listening choices, purpose of art-making, desired outcomes and perceived benefits were not gathered. Further exploration of the quality of engagement, such as the purpose of music listening, or level of mastery would allow more granular examinations of the change mechanisms involved in everyday arts participation and its implications for public health. This study focused on mortality as the outcome, but future studies might also explore other issues older adults face, in particular how different forms of arts engagement may benefit specific ADLs or chronic conditions. Examination of differences in arts engagement by race and ethnicity is another potential area for future research. The present study found that a higher percentage of Black and Hispanic participants listened to music than White or other participants, and Black participants were the highest percentage of participants who sing or play an instrument. These types of arts engagement are potential resources for minority groups who are facing social disparities.

In conclusion, an association was found between arts engagement and decreased risk of mortality among US adults. This association was especially robust for older adults. The results from this study add to a growing body of literature that advocates for greater access and inclusion of the arts in everyday life. Future research might explore lifetime participation in the arts and how changes in arts participation influence outcomes over time, the association between arts engagement and other health factors, and the benefits of arts engagement for different racial and ethnic groups. Based on the findings from this study, greater access and integration of arts in everyday life is recommended.

Author statements

Ethical approval

These data have been released to the public and is not individually identifiable. Ethical approval was not required.

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Competing interests

The authors declare that they have no competing interests.

Availability of data

Data used in this study has been publicly released and is available from the Health and Retirement Study website: https://hrs.isr.umich.edu/.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2021.05.034.

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Short Communication

Clowning during COVID-19 – A survey of European Healthcare Clowning Organisations highlights the role of humour and art in the healthcare system

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ABSTRACT

Objectives: This paper presents the findings of a Europe-wide survey that investigates the impact of COVID-19 on Healthcare Clowning Organisations and encourages the healthcare community to reflect on the role of medical clowning within the healthcare system.
Study design: Online survey.
Methods: The survey was conducted in June 2020. Forty organisations from 21 countries across Europe responded through a mix of closed and open-ended answers.
Results: During the pandemic, 36 out of 39 of the surveyed organisations (with one non-response) had to postpone or cancel their artistic activities. As the crisis continued, 34 out of 40 of them managed to adapt their in-person activities, but the impact of virtual and distanced interactions with the beneficiaries was generally perceived as lower than that of in-person activities. In open responses, many Healthcare Clowning Organisations criticised the exclusion of medical clowns from healthcare institutions in times when the need for psychosocial support was particularly acute.
Conclusions: The healthcare sector should reconsider the important role the medical clowns play within healthcare settings, and allow for more inclusive and flexible safety regulations that take into consideration the holistic well-being of vulnerable groups, especially children, the elderly, and medical staff.

As the COVID-19 pandemic continues to devastate vulnerable populations, we are ever more seriously in need of laughter. Humour increases positive emotions and decreases negative ones and helps people reinterpret stressful situations from a less threatening point of view.[1] The evidence linking humour to physical health is still inconclusive, but it is clear that, as a fundamentally social activity, humour can strengthen interpersonal bonds, raise morale, and help people preserve hope in otherwise disempowering conditions.[1] Humour is thus a tool for strengthening resilience in the face of stress or trauma.

As artists trained to bring the benefits of humour to people in need of joy, medical clowns can accordingly play an important role in mitigating this crisis. A systematic review of controlled trials indicates that medical clowns have a significant, quantifiable impact on children's well-being, although most of the studies have a moderate risk of bias.[2] According to the available evidence, medical clown visits decrease children's and parents' anxiety, as well as lowering children's pain, stress, and cancer-related fatigue.[2] Medical clowns also benefit hospital staff by reducing their negative emotions, making the hospital atmosphere less stressful, and facilitating their communication with children.[3]

Another target group that may benefit from clown interventions are the elderly. The monotony and loneliness many of them experience in residential care facilities, paired with their loss of control and independence, tends to exacerbate negative feelings and any pre-existing medical condition.[4] Preliminary research suggests that clowning may improve the mood, quality of life and social engagement of elderly people while reducing dementia symptoms, particularly agitation.[5]

The COVID-19 pandemic and associated social-distancing measures have increased loneliness and stress throughout society, but these populations targeted by medical clowns –

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hospitalised children, elderly people and healthcare staff – have been particularly affected. Children and young people are likely to suffer negative effects from loneliness, such as higher levels of anxiety, suicidal ideation and self-harm.[6] Yet hospitalised children have been affected by health and safety restrictions that limit visitors, creating ethical dilemmas that weigh physical risk against the emotional and psychological risk of isolation.[7] Meanwhile, senior care facilities have tried to protect elderly residents by keeping human contact at an absolute minimum, despite the well-established importance of social interaction to the physical and mental health of the elderly.[8] As one physician described the situation in long-term care facilities, 'my patients have become prisoners in their one-bedroom homes, isolated from each other and the outside world'.[8] The staff members who have had to navigate and implement these policies while also worrying about their own safety have suffered from high levels of anxiety and demoralisation.[9]

Efhco (the European Federation of Healthcare Clowning Organisations), in cooperation with RED NOSES International, conducted a survey in June 2020 among Healthcare Clowning Organisations working with professionally trained and remunerated clown artists in Europe. The survey consisted of 34 closed and open-ended questions with the aim of capturing the impact of the first phase of the pandemic in different organisational departments, including the artistic sphere, communications, fundraising and human resources. Questions were also dedicated to learning about networks of cooperation among the organisations during the crisis and the organisations' forecast for the future.

Out of 117 organisations contacted via email, representatives of the management of 40 organisations across 21 European countries responded to the survey. This paper does not report on the responses to every question in the survey but is rather confined to presenting those findings that are relevant to understanding the role of humour and art in the healthcare system. In particular, this paper focuses on the artistic response of Healthcare Clowning Organisations to the restrictions imposed by medical facilities during the pandemic. Results that pertain to the partnerships between Healthcare Clowning Organisations and medical institutions have also been included.

In relation to the artistic sphere, 36 out of 39[a] of the surveyed organisations reported that they had to postpone or cancel their artistic activities, including clown visits to paediatric wards, geriatric homes and centres for children with disabilities. Nonetheless, the health care clowning sector has demonstrated flexibility and creativity to continue serving vulnerable populations during the crisis; 34 out of 40 surveyed organisations found a way to adapt their traditional visits or create new forms of humorous interventions. At the same time, 27 out of 37 organisations[b] created some brand new communication activities in order to engage with their beneficiaries, the donors and the public in new ways.

The main strategy mentioned by 27 organisations was to go digital. Organisations started to produce and upload videos of live online clown performances, with different videos tailored for different age groups, from newborn babies to adults, and for different target groups, such as patients and health care staff. Furthermore, many surveyed organisations managed to continue their in-person activities in a safe manner by organising concerts and clown performances outside of the medical and social facilities, in front of windows or balconies and in courtyards. The response of the patients during some of the performances was extremely positive, as described by the French organisation Compagnie du Bout du Nez: '*Even behind a glass, even behind a mask, they recognized us. An old lady came up to the window in order to put her hand against the hand of a clown. It was just a moment of shared joy and sadness*'.

While most of the Healthcare Clowning Organisations that participated in the survey managed to adapt their artistic activities, they noted that these distanced and virtual forms of interaction had a lower impact than their usual face-to-face visits. According to the survey, 16 of the 28 organisations who adapted their activities from in-person to online in paediatric wards perceived that their activities had a lower impact on the children. Aoife's Clown Doctors Ireland reported that '*The clowns and the children are missing the one-on-one personal interaction*'. The perceived impact of the clown activities was slightly higher in elderly homes; only 10 of the 21 organisations who adapted their activities in elderly homes perceived a lesser impact. Some organisations suggested that their visits to elderly homes had a higher impact during COVID-19 because their need for contact to the outside was particularly high, as most of them were denied visits even from close family members and were left alone during the pandemic. As the Croatian organisation Crveni Nosovi mentioned: '*The elderly dancing and singing in their balconies during the concerts was particularly moving and enchanting – seeing the joy, energy and longing for being a part of the community and activities again*'.

Many surveyed organisations were critical of the fact that they were barred from entering medical facilities and could not continue their work. This situation impacted the livelihood of the medical clowns, with 17 out of 37 of the organisations[c] having to reduce the working time of their artists by between 50% and 80%. At the same time, the reduction of the amount of work resulted in 31 out of 37 respondents[d] expecting a lower revenue in 2021.

The exclusion of medical clowns from healthcare facilities raises questions over their role in the medical context and their absence in the safety regulations that allow essential personnel within medical facilities during the pandemic. For Healthcare Clowning Organisations, this experience was the most commonly mentioned learning from the crisis: 11 out of the 29 organisations who responded to this question wrote that there is the need to reconsider the positioning of medical clowns within the public health system. The Austrian organisation Rote Nasen reflected the shared sentiment: '*We want to be an indispensable partner of healthcare institutions. The COVID-19 crisis showed how important our work is, not only for our existing beneficiaries but for all people in the need of joy*'.

Of course, the Healthcare Clowning Organisations responding to the survey have a vested interest in the ability of medical clowns to continue their work. Yet leading international organisations such as the United Nations and the World Health Organisation have also acknowledged that mental health and psychosocial support must be a 'core component' of any public health response, including within general health services.[10] The COVID-19 pandemic has put health care facilities under unprecedented pressure and uncertainty as they work to protect their patients, but this protection was initially reduced to physical care. At the start of the pandemic, medical clown visits were almost all cancelled, suggesting that the psychological and emotional care of patients was overlooked. The creative responses of Healthcare Clowning Organisations show that it is possible to provide humour relief even when restricted from entering medical and care facilities. Yet, while further research is needed to understand the opportunities and deficits of virtual clowning, anecdotal evidence from the survey indicates that the impact of clowns' work did suffer. Lessons learnt from COVID-19

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[a] With one non-response.

[b] With three non-responses.

[c] With three non-responses.

[d] With three non-responses.

may be used to reconsider the role of medical clowns in the health care system so that institutions are better enabled to support the holistic well-being of vulnerable groups, especially children in hospitals, medical staff and the elderly.

Author statements

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Ethical approval

Ethical approval was not required for this study, as no interventions were performed, no vulnerable populations were involved, and no sensitive data was collected.

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Competing interests

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Original Research

Distinguishing independent and shared effects of material/structural conditions and psychosocial resources on educational inequalities in self-rated health: results from structural equation modelling

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ABSTRACT

Objectives: The aim of this study was to distinguish independent and shared effects of material/structural factors and psychosocial resources in explaining educational inequalities in self-rated health (SRH) by using structural equation modelling.
Study design: Cross-sectional survey.
Methods: Data were derived from a questionnaire sent to a random sample of the population in five counties in Sweden in 2008. The study population (aged 25–75 years) included 15,099 men and 17,883 women. Exploratory structural equation modelling was used to analyse the pathways from educational level to SRH.
Results: The pathway including both material/structural factors (e.g. financial buffer and unemployment) and psychosocial resources (e.g. sense of coherence and social participation) explained about 40% of educational differences in SRH for both men and women. The pathways including only the independent effects of psychosocial resources (14% in men and 20% in women) or material/structural factors (9% and 18%, respectively) explained substantial but smaller proportions of the differences.
Conclusions: The major pathway explaining educational inequalities in SRH included both material/structural factors and psychosocial resources. Therefore, to reduce educational inequalities in SRH, interventions need to address both material/structural conditions and psychosocial resources across educational groups.

Introduction

The persistence of social inequalities in health, also in the highly developed 'welfare states' of Western Europe, has been called one of the great disappointments of public health.[1] Social inequalities in health have been found for most measures of socioeconomic status (SES), e.g. education, income and occupation, and for most health outcomes, e.g. mortality, morbidity in several diseases and self-rated health (SRH).[2–6] In Sweden, low-education groups have a doubled risk of reporting poor SRH compared with high-education groups,[7] and social inequalities in health have widened over time.[3] There are two main explanations for the persisting inequalities: the material/structural and psychosocial pathways.[1]

The *materialist/structural explanation* focuses on deficiencies in tangible material goods and structural conditions which are more common in low-SES groups.[8,9] The *psychosocial pathway* implies that inequalities in health are due to an imbalance between exposures to stressors and available protecting psychosocial resources.[10–12] It has, however, been shown that the contributions of material/structural factors and psychosocial resources to SES inequalities in health are not mutually exclusive.[13–15] Instead, a

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substantial part of these inequalities is a result of complex pathways with shared contributions, although the relative importance of these shared pathways is not fully understood.[15–17]

In order to design efficient interventions to reduce SES inequalities in health, it is necessary to understand to what extent the main contributors to the inequalities are independent of each other and to what extent they arise from a shared effect.[18,19] See Fig. 1 for a conceptual model.

Few previous studies have distinguished the importance of the independent and the shared contributions of material/structural and psychosocial factors. A study of the Arab minority in Israel showed that almost all the effect of psychosocial resources on educational inequalities in SRH disappeared when material conditions (in terms of financial resources) were taken into account,[14] indicating a shared effect. Another study, using cross-national data from 28 countries in Europe, showed that most of the contribution of psychosocial factors to SES inequalities among employed men and women was shared with material/structural factors.[13] Both these studies were included in a systematic review by Moor et al.[15] The review showed that the psychosocial pathway is important for SES inequalities in SRH but that the contribution of psychosocial factors, when taking material/structural factors into account, is much smaller than when the psychosocial factors are analysed separately. Therefore, Moor et al. concluded that 'studies aiming to explain social inequalities in health need to consider more than one pathway.'[15] Notably, all studies included in the review were based on logistic regression models, with separate models for the independent effects and the shared effects. To assess the extent to which associations can be explained in terms of independent or shared pathways, it is preferable to analyse all pathways of interest in the same model, and more recent methods, such as structural equation modelling (SEM), have therefore been suggested.[20]

Thus, the aim of this study was, by using SEM, to distinguish and quantify the relative importance of the independent and the shared contributions of material/structural factors and psychosocial resources in explaining educational inequalities in SRH.

Methods

Study settings and participants

The present study used data from a cross-sectional postal public health survey, the Life and health study 2008, addressed to a random sample from the population aged 18–84 years in five counties in the central part of Sweden. The population of the five counties consists of more than one million inhabitants, and the sample frame was the total population register at Statistics Sweden, covering all inhabitants in the area. The survey was carried out during March–May 2008. The total sample size was 68,710. Data collection was discontinued after two postal reminders failed to elicit a response, resulting in an overall response rate of 59%. Non-response bias can often be a problem when estimating levels or

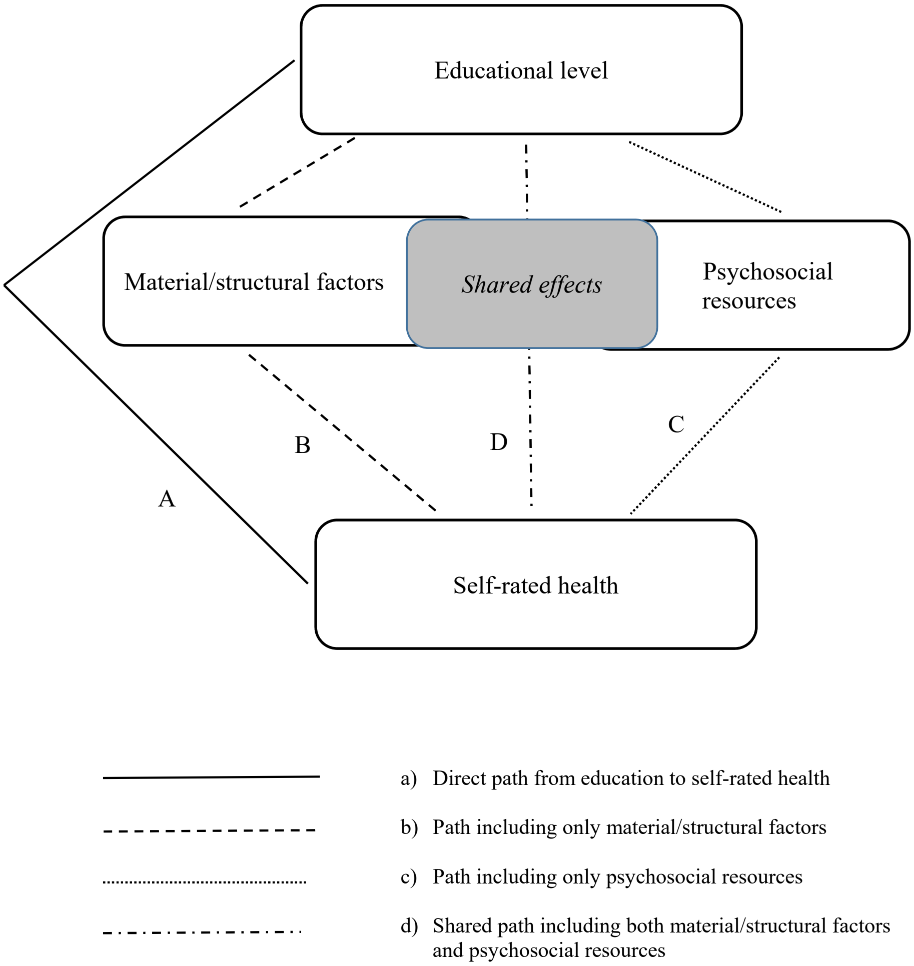

Fig. 1. Conceptual model of pathways from educational level to self-rated health, including the independent effects of material/structural factors and psychosocial resources, respectively, and the shared effects of material/structural factors and psychosocial resources.

proportions, but when estimating associations, as in the present study, the non-response bias is normally less severe.[21] Therefore, no weighting to handle a potential non-response bias was used. As individuals with postsecondary education rarely reach their final level of education before the age of 25 and the national education register is not complete for those older than 75 years, a subsample of the survey containing men and women aged 25–75 years, comprising 32,982 participants, was selected.

Participants gave their informed consent that questionnaire data would be linked to Swedish official registries by Statistics Sweden through personal identification numbers. After the record linkage, all identity information was removed before the material was handed over from Statistics Sweden to the county councils. Study data are protected pursuant to the laws of official statistics and secrecy. More details about the survey can be found elsewhere.[22]

Measures

Educational level. Educational level was obtained from the national education register and was classified into low (elementary school), medium (upper secondary school) and high education (at least two years of university or corresponding education).

Self-rated health. SRH was measured on a five-grade scale with the options 'very good', 'good', 'neither good nor poor', 'poor' and 'very poor'. In the present study, the first two options were classified as good, and the rest as poor.

Material/structural factors. Among material factors, poverty and economic hardship are major contributors to SES inequalities in health.[23] In the present study, two indicators of economic hardship were included: *financial buffer*, assessed by a question about whether the respondent in the course of a week was able to raise an amount of 20,000 SEK (approx. EUR 1900), and *inability to meet expenses*, assessed by a question on difficulties in managing current expenditures for food, rent, bills and so on during the past 12 months. Both these measures have been shown to be associated with SRH in previous studies.[7,24]

Structural factors extend the material approach to include also social concomitants.[9] This concept can relate to the labour market, to the family situation as well as to civic participation. In the present study, three measures of structural factors were included: membership in associations, living in a single household and unemployment. *Membership in associations* was assessed by the question: "Do you participate in activities or attend meetings in any group, organisation, association or communion?", which was dichotomized (yes/no). *Single household* was defined as a person living alone and was derived from two questions on family structure. *Unemployment* (yes/no) was derived from a question on current employment status. As the usual age of retirement in Sweden is 65 years, respondents older than 64 years in most cases reported their main occupation to be retired because of old age. These were given the unemployment status 'no'.

Psychosocial resources. A major argument for the hypothesis of psychosocial pathway to SES inequalities in health is that psychosocial resources are, in general, not equally distributed over SES groups.[11] External psychosocial resources comprise protective factors in the social environment. Two major domains are social support,[25] comprising emotional and practical support, and social participation,[26] describing being integrated in and interacting with the wider social community. Both social support and social participation are associated with SRH.[24,27] In the present study, both social support and social participation were included as measures of external psychosocial resources. *Social support* was assessed by three questions: 'Do you have any persons in your surroundings from whom you can get support in emotional crises or problems?', '… from whom you can get help with shopping and cooking in case of disease?' and '… who could help you if you were moving to a new place?', with response options 'Yes, certainly' (3), 'Yes, probably' (2), 'Probably not' and 'No'. The two latter groups were small and had similar characteristic and were therefore combined into one group (1). Using factor analysis, a variable capturing the common feature of these three questions was created, representing overall social support. *Social participation* was assessed by the question, "How often do you usually do the following things in your leisure time?" with six items included: 'Watching sports events live', 'Attend a music concert', 'Go to the theatre', 'Go to the cinema', 'Visit exhibition/museum' and 'Take part in study circle or course', all with response options 'Every day', 'Every week', 'Every month', 'Every year', 'More seldom' and 'Never'. Responding every year or more often on more than two items was considered as social participation.

Internal psychosocial resources are psychological factors representing perceived ability to handle external life strain.[28] One of the most studied resources is the concept of sense of coherence, developed by Antonovsky.[29] The concept origins from his studies of salutogenesis, i.e. determinants of health and well-being, also in difficult life situations, and comprises feeling of comprehensibility, manageability and meaningfulness. In the present study, *sense of coherence* was measured using the 13-item questionnaire (SOC-13). Another aspect of psychosocial resources is related to expectancies.[28,30] A common measure is *optimism*, conceptualised as expecting good things rather than bad things to happen in the future, shown to be a good predictor of positive health outcomes.[31,32] Optimism has been measured in various ways, including a single question about the way the respondent feels about the future.[33] In a meta-review, associations between optimism and physical health were shown to be robust irrespective of type of measure used.[31] In addition, the level of optimism has been found to vary over educational levels.[7] In the present study, optimism was measured by the question: 'How do you personally look upon the future?' with options: 'Very optimistic' (5), 'Rather optimistic' (4), 'Neither optimistic nor pessimistic' (3), 'Rather pessimistic' (2) and 'Very pessimistic' (1). The variable was used in its original 5-scale form in the analyses.

Present disease or ill-health. As SRH is influenced by manifesting physical and mental health conditions,[34] three measures of disease and ill health were included in the analyses. *Present longstanding disease* was assessed by the question, 'Do you have any longstanding disease (more than 6 months), permanent ailment from accident, impaired function or other medical disorder?' (No/Yes). *Musculoskeletal complaints* were derived from the survey question, 'During the last three months, have you experienced any of following complaints or symptoms?' 'Pain in neck or shoulders', 'Pain in back or hips' and 'Pain in hands, arms, legs, knees or feet'. *Anxiety/depression* was measured by the question in the EQ-5D instrument, asking if the respondent felt 'anxious or depressed' (not/moderately/extremely), coded as 1, 2 and 3, respectively.[35]

The choice of explanatory factors was mainly based on theoretical and evidence-based considerations but was also restricted to the items covered by the questionnaire. In addition to the included variables, we also tested to include physical living environment, receiving social security benefits, housing tenure and psychosocial living environment in the exploratory process. These variables were however found to be either too closely correlated with other variables or to lack significant exploratory value.

Data analysis

Prevalence (%) of poor SRH and categorical measures of material/structural factors and psychosocial resources were calculated by educational level, and differences over educational level groups were tested by Chi-squared test. Sense of coherence was measured on a continuous scale, but the distribution was skewed. Therefore, median and interquartile range were calculated by educational level, and differences were tested by the non-parametric one-way Kruskal-Wallis test.

The pathways from educational level to SRH were modelled in an exploratory manner, using SEM,[36] by including all available measures of material/structural factors and psychosocial resources. The models were adjusted by age, longstanding disease, musculoskeletal complaints and anxiety/depression. All possible associations between the included variables, i.e. educational level, all psychosocial resources, all material/structural factors, adjustment variables described previously and SRH, were evaluated using P-values for the standardised path coefficient estimates. Associations with P values > 0.05 were excluded from the models, except for associations involving educational level or age which were kept regardless of P values. The latter was because educational level was the primary factor of interest and because we wanted all analyses to be age-adjusted.

All analyses were stratified by sex, to find out if the relative importance of independent and shared contributions of material/structural factors and psychosocial resources differs between men and women. Illustrations of the full models, including standardised estimates, can be found in the supplementary material.

The single pathways from educational level to SRH were grouped into one of the four path types illustrated in Fig. 1, with one direct path from educational level to SRH (A) and three indirect path types from educational level to SRH (B–D). The indirect path types were (B) including only material/structural factors, (C) including only psychosocial resources and (D) including both material/structural factors and psychosocial resources (shared effect). For comparability reasons, all effects were standardised. The standardised coefficients (estimated effects) can be interpreted that the more the coefficient deviates from 0, the stronger the effect is. The total standardised effects for all individual pathways that fall into each of the path types (A, B, C and D) were estimated. The relative contributions of each of the four path types were estimated as proportions of the total effect of educational level on SRH, where the educational levels were weighted proportional to size (i.e. the number of respondents in the sample, in the low-education group and in the medium-education group, respectively).

In the models, some of the dependent variables, e.g. SRH, were dichotomous or categorical, which require the use of a probit link in the estimations. As has been recommended in such cases, the weighted least squares mean and variance adjusted estimator was used to estimate the effects in the models.[37]

As there is no definitive measure of fit for SEM models, a panel of indices have been used to evaluate how well the model reproduces the observed correlation between variables.[38] The most common measure is the Chi-squared statistics, where a significant Chi-squared value indicates poor fit. The Chi-squared statistic is, however, highly sample size sensitive,[39] so other measures, including root mean square error approximation (RSMEA), comparative fix index (CFI) and Tucker-Lewis Index (TLI), sometimes also called non normed fit index, were used as complements. Proposed cutoff values for acceptable fit are 0.06 for RSMEA (smaller values indicate good fit) and 0.95 for CFI and TLI (the closer to one, the better).[38] The SEM analyses were performed using Mplus, version 7.

Results

Sample characteristics

The proportions of poor SRH in low-education groups were twice those in high-education groups, for both men and women (Table 1).

Material/structural risk factors were more prevalent in low-education groups, particularly lack of financial buffer. Also, practically all the psychosocial resources showed educational gradients unfavourable to respondents with low education, most pronounced for optimism and social participation. Prevalence of present disease and ill health was higher in groups with low educational levels (Table 1).

SEM analyses

Table 2 presents standardised SEM estimates of effects of educational level on SRH for men and women. The model provided an excellent fit to the data according to the RSMEA, CFI and TLI values. The total standardised effects of low education on poor SRH were $b = 0.186$ for men and $b = 0.193$ for women. The total effects of medium education were $b = 0.151$ and $b = 0.133$, respectively, all $P < 0.001$ when compared to high education. For both men and women, the indirect effects of educational level on SRH, explained by psychosocial resources and/or material/structural factors, were larger than the direct effect (Table 2).

Grouping the effects according to the different path types (A, B, C and D) in men, the direct path (A) ($b = 0.075$, $P < 0.001$, for low education and $b = 0.058$, $P < 0.001$, for medium education) and the indirect pathways with shared effects of both material/structural factors and psychosocial resources (D) ($b = 0.080$, $P < 0.001$, for low education and $b = 0.053$, $P < 0.001$, for medium education) had the largest standardised effects. Summarising over all educational levels, the direct pathways from educational level to SRH corresponded to 39% (A) and the indirect pathways with shared effects of both material/structural factors and psychosocial resources corresponded to 38% (D), of the total effect for men. The indirect path type involving independent effects of psychosocial resources had a slightly larger effect than the path type only involving independent effects of material/structural factors (C = 14% vs B = 9%) among men (Fig. 2).

In women, the indirect path type involving shared effects of both material/structural factors and psychosocial resources (D) had the largest effect on SRH ($b = 0.069$, $P < 0.001$, for low education and $b = 0.058$, $P < 0.001$, for medium education) (Table 2), corresponding to 41% of the total effect when summarising over educational groups (Fig. 2). The direct effect of education (A) and the independent indirect effects of material/structural factors (B) and psychosocial resources (C) all explained around 20% each of the total educational effect.

Discussion

The results of the present study show that the shared path type including both material/structural factors and psychosocial resources explained the largest proportion of the educational inequalities in SRH, about 40%, among both men and women. In addition, among men, the independent effect of psychosocial resources explained 14% and the independent effect of material/structural factors explained 9%, whereas in women, these two path types explained around 20% each of the total educational effect. The remainder of the educational effect on SRH (the direct effect) was large (39%) in men but smaller (22%) in women.

Table 1
Descriptive statistics of age, educational level, self-rated health (SRH) and prevalence of poor SRH, material/structural factors and psychosocial resources by educational level (Life & health study 2008).

Respondent characteristics	Total population aged 25–75 years	
	Men (n = 15 099)	Women (n = 17 883)
Age		
Mean ± SD	54.5 ± 13.9	52.1 ± 14.2
Education level, % (n)		
Low	26 (3870)	20 (3608)
Medium	53 (7888)	50 (8872)
High	21 (3190)	30 (5237)
SRH, % (n)		
Good	72 (10 788)	72 (12 533)
Poor	28 (4092)	28 (5006)
Prevalence by educational level		
Poor SRH, % (n)		
Low	36 (1364)	42 (1483)
Medium	27 (2104)	28 (2474)
High	18 (574)	19 (992)
	$P < 0.001$	$P < 0.001$
Material/structural factors		
No financial buffer, % (n)		
Low	19 (715)	30 (1058)
Medium	16 (1208)	26 (2307)
High	7.7 (242)	12 (641)
	$P < 0.001$	$P < 0.001$
Inability to meet expenses, % (n)		
Low	9.6 (363)	12 (420)
Medium	14 (1070)	17 (1493)
High	9.8 (308)	13 (649)
	$P < 0.001$	$P < 0.001$
Not a member in any association, % (n)		
Low	66 (2558)	68 (2442)
Medium	56 (4458)	62 (5518)
High	44 (1406)	50 (2647)
	$P < 0.001$	$P < 0.001$
Living in a single household, % (n)		
Low	18 (702)	26 (922)
Medium	16 (1220)	16 (1374)
High	14 (435)	14 (759)
	$P < 0.001$	$P < 0.001$
Unemployment (25–64 years), % (n)		
Low	3.7 (67)	4.8 (78)
Medium	3.0 (175)	4.2 (297)
High	1.7 (40)	2.2 (95)
	$P < 0.001$	$P < 0.001$
Psychosocial resources		
Sense of coherence median (interquartile range)		
Low	73 (17)	71 (20)
Medium	72 (17)	69 (19)
High	74 (15)	73 (16)
	$P < 0.001$	$P < 0.001$
Optimism,[a] % (n)		
Low	60 (2286)	58 (2057)
Medium	67 (5211)	68 (5960)
High	74 (2351)	75 (3901)
	$P < 0.001$	$P < 0.001$
Social support in emotional crises or problems,[b] % (n)		
Low	67 (2544)	72 (2541)
Medium	68 (5266)	76 (6660)
High	74 (2320)	81 (4234)
	$P < 0.001$	$P < 0.001$
Social support in case of disease,[b] % (n)		
Low	77 (2917)	76 (2682)
Medium	77 (6042)	80 (7080)
High	80 (2527)	83 (4304)
	$P = 0.01$	$P < 0.001$
Social support in case of moving,[b] % (n)		
Low	71 (2713)	75 (2661)
Medium	74 (5768)	78 (6845)
High	75 (2362)	79 (4114)
	$P = 0.01$	$P < 0.001$
Social participation, % (n)		
Low	62 (2221)	54 (1745)
Medium	77 (5851)	75 (6298)
High	88 (2699)	91 (4530)
	$P < 0.001$	$P < 0.001$
Present disease or ill health		
Prevalence of longstanding disease, % (n)		
Low	35 (1317)	38 (1332)
Medium	29 (2234)	33 (2837)
High	26 (820)	27 (1390)
	$P < 0.001$	$P < 0.001$
Prevalence of any musculoskeletal complaints, % (n)		
Low	52 (1921)	65 (2219)
Medium	46 (3542)	61 (5236)
High	34 (1052)	51 (2611)
	$P < 0.001$	$P < 0.001$
Prevalence of anxiety/depression, % (n)		
Low	9.6 (364)	19 (659)
Medium	10 (787)	20 (1703)
High	8.4 (265)	18 (900)
	$P = 0.02$	$P = 0.01$

[a] Includes response options 'very optimistic' and 'rather optimistic'.
[b] Includes response options 'Yes, certainly'.

The finding that the shared effect of material/structural factors and psychosocial resources was more important than the independent effects is in line with the conclusion of the review by Moor et al.,[15] where the interdependence of these factors was emphasised. Our finding supports and elaborates their conclusion, as we were able to quantify the relative importance of the independent and the shared contributions. However, among the independent effects, Moor et al. found that material factors had the strongest effect.[15] In the present study, the independent effects of material/structural factors and psychosocial resources were about the same size in women, whereas the psychosocial resources had a somewhat stronger effect among men. There are several possible explanations for these diverging findings. First, of the studies included in the review, which involved both material/structural and psychosocial factors, only one study included measures of both external and internal psychosocial resources. The other studies included only external psychosocial resources. Both internal resources, such as sense of coherence and optimism, and external resources, such as social support, are important buffers to external stressors.[40] In the present study, we examined several measures of both internal and external psychosocial resources. Our finding that the effects of psychosocial resources were strong is in line with the literature, e.g. the study by Marmot and Wilkinson[41] on the fundamental importance of psychosocial factors for SES differences in health and their relationship with both mental and somatic disease and ill health. The effects of psychosocial resources can also be traced by psychobiological mechanisms and disease vulnerability.[11]

Also, the different results may be due to the fact that the review was based on studies using logistic regressions, where a series of regression models were compared.[42] Such standard regression approach can be problematic and has been shown to be inferior to SEM when performing analysis of relative contribution of different pathways.[43,44] The problem is even aggravated when *logistic* regression models are used because odds ratios from different logistic regression models are not fully comparable.[45] Accordingly, the authors of the review concluded that 'there are more recent methods regarding mediation analysis which none of the included studies used'.[15]

Thus, a particular strength of the present study is the use of SEM, especially the path analysis component. This analytical method has been suggested as a useful tool in modelling the different pathways linking social structure to health because the method is able to

Table 2
Standardised effects of educational level on poor self-rated health and effects of material/structural factors and psychosocial resources based on structural equation modelling, men (N = 15,099) and women (N = 17,883) aged 25–75 years.

Educational level	Pathway from educational level to self-rated health	Men		Women	
		Estimated effect	*P* value	Estimated effect	*P* value
Low[a]	Direct	0.075	<0.001	0.063	<0.001
	Indirect	0.112	<0.001	0.131	<0.001
	Via material/structural factors[b]	0.013	<0.001	0.024	<0.001
	Via psychosocial resources[c]	0.019	<0.001	0.038	<0.001
	Via material/structural factors[b] and psychosocial resources[c]	0.080	<0.001	0.069	<0.001
	Total	0.186	<0.001	0.193	<0.001
Medium[a]	Direct	0.058	<0.001	0.020	0.175
	Indirect	0.093	<0.001	0.112	<0.001
	Via material/structural factors[b]	0.015	<0.001	0.028	<0.001
	Via psychosocial resources[c]	0.025	<0.001	0.026	<0.001
	Via material/structural factors[b] and psychosocial resources[c]	0.053	<0.001	0.058	<0.001
	Total	0.151	<0.001	0.133	<0.001
Model statistics	N	14 948		17 717	
	R2	0.647		0.690	
	Chi-square	845.941		890.948	
	RSMEA[d]	0.029		0.026	
	CFI[e]	0.988		0.990	
	TLI[e]	0.973		0.978	

RSMEA, root mean square error approximation; CFI, comparative fix index; TLI, Tucker-Lewis Index.
Note: Indirect effects are calculated by taking the product of all paths leading from the predictor to the outcome. Total effects are the sum of direct and all indirect effects. The models are adjusted for age, longstanding disease, musculoskeletal complaints and anxiety/depression.

[a] The reference category for educational level is high education.

[b] Material/structural factors include financial buffer, inability to meet expenses, membership in associations, single households and unemployment.

[c] Psychosocial resources include sense of coherence, optimism, social support and social participation.

[d] Values smaller than 0.06 indicate acceptable fit (Hu and Bentler, 1999).

[e] Values larger than 0.95 indicate acceptable fit (Hu and Bentler, 1999).

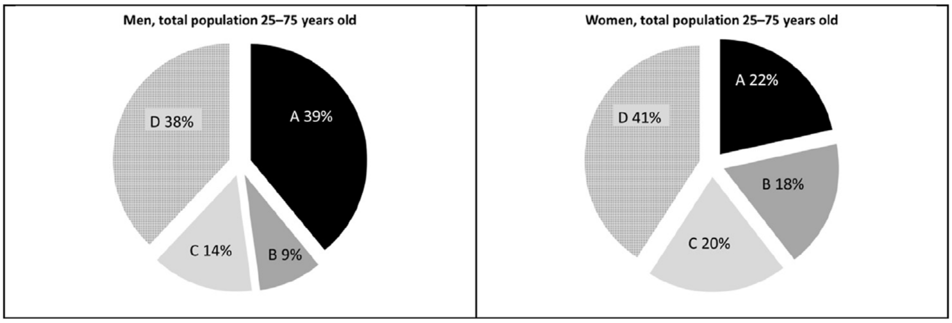

Fig. 2. Standardised total effect of educational level on self-rated health by different pathways (%). A, direct effect (involving neither material/structural factors nor psychosocial resources); B, indirect effect by material/structural factors; C, indirect effect by psychosocial resources; D, shared indirect effects by both material/structural factors and psychosocial resources.

structure several relations in a sequential system, which goes beyond the use of interaction terms in common logistic regression models.[20] Furthermore, SEM can handle multiple pathways with both independent and shared effects in a single model.[46] To our knowledge, no other studies have applied this tool for distinguishing independent and shared effects of psychosocial and material/structural factors on educational inequalities in health. A further strength of the study is that material/structural factors were not confined to financial resources only but also included structural living conditions, which are important when studying SES inequalities in health.[15]

Although it has merits, we are aware of several limitations. The survey data used are from 2008. However, previous studies have shown that educational health inequalities in Sweden are persistent or even widening[3,47] and that the impact of the determinants of the inequalities has been stable over time.[7] The non-response rate was about 40%. As people with poor health and/or low education often have lower response rates, this may lead to underestimation of health inequalities in our findings. Also, as the results may depend on the measures used, further studies are needed to examine the robustness of our findings.[48] However, the fact that the measures used in the present study explained the majority of the educational differences in SRH, especially among women, indicates that the set of variables used in the present study catches a large part of important material/structural factors and psychosocial resources.

Levels of financial security among disadvantaged groups are higher in Sweden than in many other countries, and thus, the results may not be generalisable to an international context. However, as can be seen from the present data, also in this Swedish population, a substantial proportion was lacking financial buffer and/or had problems with meeting the expenses. Moreover, the results concern SRH, and generalisation to other health outcomes may not be appropriate. As a consequence of the cross-sectional design, it was not possible to conduct a straight-forward mediation analysis, i.e. to determine how one factor influences the outcome through a mediator variable. Thus, we cannot fully assess whether the contribution of psychosocial resources was a function of material/structural factors or if the effects of material/structural factors were functions of psychosocial resources. Therefore, future longitudinal studies would be a valuable complement to existing knowledge. However, we can conclude that the shared effect had the largest contribution to the inequalities in the present study.

The results of the present study reflect the common pattern for all respondents aged 25–75 years. An interesting topic for future studies would be to investigate whether the contributions of material/structural factors and psychosocial resources to health inequalities vary by age groups. Another interesting topic might be to investigate the working population using SEM analysis, which would enable to add physical and psychosocial working conditions to the list of explanatory variables. This would further elucidate the contributions of material/structural factors and psychosocial factors to educational differences in SRH in this subgroup. Finally, as our analysis only included material/structural and psychosocial factors, the contribution of other types of factors, e.g. health behaviours, was implicitly included in either the direct effect from educational level to SRH or in the effects involving psychosocial resources.[49] This may explain why the direct effect of education was substantial, especially among men. Behavioural factors are important to explain SES inequalities in health, but as the primary purpose of the present study was to compare the relative importance of the independent and the shared contributions of material/structural factors and psychosocial resources in explaining educational inequalities in SRH, we chose to focus on these two types of factors to simplify an already complex network of associations. Our finding of the large size of the shared effect of material/structural factors and psychosocial resources is in line with policy strategies launched decades ago by WHO.[50] Thus, interventions to reduce inequalities in health need to include policies to improve not only economic resources for the poorest[51] but also interventions supporting psychosocial resources. Such interventions should include empowerment strategies and development of health-promoting living arenas in neighbourhoods, at workplaces and in schools, to enable social support, trust, hope and optimism.

In summary, we found that the major contribution of material/structural factors and psychosocial resources to educational inequalities in SRH was in the form of shared effects of these factors. Measures to reduce educational inequalities in SRH need therefore to address both material/structural conditions and psychosocial resources across educational groups.

Author statements

Ethical approval

According to The Ethical Review Act of Sweden (2003:460) at the time of data collection, ethical vetting of research involving deidentified humans was not required.

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Competing interest

None declared.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2021.04.032.

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Original Research

Does fact-checking habit promote COVID-19 knowledge during the pandemic? Evidence from China

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Coronavirus
Knowledge
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Fact-checking

ABSTRACT

Objectives: Promoting health knowledge during a public health crisis is essential. This study aims to examine how fact-checking habit influences COVID-19 knowledge in the COVID-19 infodemic.
Study design: This study uses a cross-sectional survey.
Methods: During the early outbreak of COVID-19 in China, we conducted an online survey and collected data from 3000 representative Chinese Internet users. The study measured COVID-19 knowledge as a dependent variable, fact-checking habit as an independent variable, and general science knowledge and negative emotion as moderators. Internet use and several demographic factors were used as control variables. Ordinary least squares (OLS) linear regression analysis was conducted to examine the relationship between fact-checking habit and COVID-19 knowledge as a function of science knowledge and negative emotion.
Results: Fact-checking habit was negatively associated with COVID-19 knowledge, and the relationship was moderated by general science knowledge and negative emotion. For those with less science knowledge or higher levels of negative emotion, COVID-19 knowledge was lower with the increase of experience in fact-checking.
Conclusions: During a pandemic, individuals may not be able to obtain high-quality information, even if they regularly fact-check information, and especially when they lack knowledge about science or are influenced by negative emotion. To promote health knowledge during a public health crisis, basic science literacy must be promoted, and the psychological impact of the crisis on the population must also be considered.

Introduction

Amid the COVID-19 global pandemic, people were eager to know more about the virus, which was seen by the sharp increase in information seeking related to COVID-19.[1] Health knowledge can advance health behaviors;[2,3] therefore, improving health knowledge is essential in health promotion.[4] However, during the pandemic, the abundance of both accurate and inaccurate information makes it difficult for people to obtain knowledge about COVID-19.[5] Often, people are overwhelmed by the infodemic and misled by inaccurate information.[6] According to the World Health Organization (WHO), an infodemic is ‘too much information, including false or misleading information, in digital and physical environments during a disease outbreak. It causes confusion and risk-taking behaviours that can harm health’.[7] During the early outbreak of COVID-19 in China, a large amount of inaccurate information about COVID-19 misled people into excessive prevention behaviors.[8] Outside of China, misleading preventive advice (e.g. drinking bleach, which went viral on the Internet) resulted in approximately 5800 people to be admitted to hospital and at least 800 deaths by August 12, 2020.[9]

Given the increasing need for COVID-19 knowledge and the negative impacts of inaccurate information, there is an urgent call for fact-checking to cope with the COVID-19 infodemic.[10] It is expected that individuals can identify inaccurate information and obtain useful knowledge by fact-checking what they read.[10] Against this background, the current study aims to examine how fact-checking practices can influence COVID-19 knowledge.

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Research framework

Obtaining knowledge from a massive amount of information requires skill and literacy. Fact-checking is one of the applications of information literacy.[11–13] Fact-checking (also known as 'verification' or 'authentification'[13,14]) refers to an individual's behaviors of determining whether a piece of information exists or is true (e.g. by using a search engine to search for more related information). Therefore, fact-checking is a process of learning. Ideally, individuals who fact-check what they read are more likely to obtain knowledge instead of inaccurate information,[10] and the knowledge can help people make correct decisions.[15] An increasing number of journalists and scholars are encouraging people to fact-check what they read.[16–18] Eysenbach[10] considered fact-checking as one of the four pillars of infodemic management. However, to date, the relationship between fact-checking and knowledge obtainment has not been empirically examined. Do people who are more experienced in fact-checking obtain more knowledge about COVID-19 than those who are not? The current study aims to answer this question.

When individuals perform fact-checking, they expose themselves to more information. However, not everyone can refine knowledge from what they read efficiently. Whether people can gain new knowledge largely depends on their existing knowledge, which is known as the 'Matthew effect' in education.[19] Those who have more reading ability obtain more literacy by reading.[20,21] Following this line of reasoning, those who have more existing science knowledge should be more capable of judging the authenticity of COVID-19 information and obtain more knowledge by fact-checking.

The outcome of learning can also be affected by emotion. Studies suggest that students' learning outcomes can be enhanced by positive (e.g. happy, joyful) but not negative (e.g. anxious, fear) emotion in learning.[22,23] However, it is important to note that fact-checking under the influence of an infodemic is different from learning in school. People are exposed to both accurate and inaccurate information when they fact-check. Usually, negative emotion alerts individuals and elicits systematic as well as accommodative information processing, which leads them to focus on the actual details of the world.[24,25] On the contrary, positive emotion signals a predictable environment and induces assimilative and constructive processing, so the individuals rely more on existing knowledge and heuristic, schematic thinking to perform a task.[24,25] As a result, people with positive emotion are more likely to fall for misleading clues when they are exposed to both accurate and inaccurate information.[26] Also, people tend to hold false memories of what they have seen.[27] Therefore, when individuals perform fact-check, negative emotion can help them process the given information more systematically, whereas positive emotion increases the likelihood of being misled by inaccurate information.

Based on the current literature, the present study aims to investigate the impacts of fact-checking habit on the obtainment of COVID-19 knowledge and to examine how the effects vary with different levels of science knowledge and negative emotion. The findings of this study will help understand the determinants of health knowledge during a public health crisis.

Methods

Data collection

The data for this study were collected between 2 March and 23 March 2020 in mainland China. Data collection was outsourced to a commercial survey research company who have 4 million Internet panel members in China. To achieve a representative sample, we used a stratified quota sampling technique to recruit respondents. The quotas for subcategories of gender, age, and education groups were based on the most recent China Internet Network Information Center (CNNIC) report.[28] This sampling method was used to recruit 3000 respondents aged >18 years, with a response rate of 24.6%.

Sample size

We followed Daniel and Cross's formula[29] to calculate the survey sample size. According to the 44th CNNIC report, there are 939,840,000 Internet users in China.[28] To reach a criterion of 3% margin of error and 99% confidence level, the sample size should be 1844. However, given the geographical diversity of the Chinese population, we increased the target sample size to 3000.

Measures

COVID-19 knowledge

This study measured COVID-19 knowledge by examining respondents' trust in six popular false statements about COVID-19 in China. To avoid the examination effect, two of the sentences were reversely stated as true statements. Respondents were asked to indicate whether they believed the statements on a 4-point scale, ranging from 1 'definitely false' to 4 'definitely true'. The answers for the false statements were reversely coded. Respondents scored 1 when they thought the statement was 'definitely true' or 'true' and scored 0 when they thought the statement was 'definitely false' or 'false'. The total score of all six items formed the knowledge index ($M = 1.41$, $SD = 0.35$).

Fact-checking

By adapting Edgerly et al.'s[30] measures of fact-checking, we asked the respondents how likely were they to perform the following checking strategies after reading information online: check other major news outlets, ask friends/family members, use search engines, check social media (e.g. Weibo, WeChat) and consult other sources. Respondents reported their answer on a 5-point Likert scale, from 1 'very unlikely' to 5 'very likely'. The average of these items formed the fact-checking index ($\alpha = 0.88$, $M = 3.74$, $SD = 0.87$).

Table 1
Demographic characteristics of respondents (N = 3000).

Variable	Present sample (%)	Sixth China Census data (%)
Age in years		
18-29	32.50	25.69
30-39	29.40	20.42
40-49	21.50	21.86
50-59	8.30	15.19
≥60	8.30	16.85
Sex		
Male	52.40	51.19
Female	47.60	48.81
Education		
Primary school or below	18.00	33.75
Secondary school	38.10	41.70
High school	23.80	15.02
College	10.50	5.52
University or above	9.70	4.01
Income		
<6000	7.50	–
6001–10,000	28.80	–
10,001–30,000	49.60	–
30,001–60,000	10.10	–
≥60,001	4.00	–
Region		
Rural	39.20	49.73
Urban	60.80	50.27

Table 2
COVID-19 knowledge, fact-checking habit, science knowledge, and negative emotion.

Variables	Percentage
COVID-19 knowledge (scale 1–4)	**Score 3–4, very likely–very likely**
Drinking alcohol will not reduce coronavirus risk. (True)	70.5%
Viruses are more virulent in cold and wet weather, thus turning on air-conditioners or heater up to 30° could fight the coronavirus. (False, reverse code)	53.7%
The coronavirus lasts longest on the smooth, non-porous surfaces; thus, the virus survives longer on a sweater than the metal surface. (True)	51.8%
The coronavirus is a bio-weapon developed by the United States. (False, reverse code)	56.0%
Going out with ginger slices in the mouth can prevent the coronavirus. (False, reverse code)	60.7%
The coronavirus is only infecting and killing Asians, but not Caucasians (False, reverse code)	65.6%
Fact-checking habit (scale 1–5)	**Score 4–5, likely-very likely**
Check other major news outlets.	56.4%
Ask friends/family members.	49.3%
Use search engines.	58.4%
Check social media (e.g. Weibo, WeChat).	49.8%
Consult some other sources.	44.6%
Science knowledge (scale 0–1)	**Score 1, correct**
Antibiotics kill viruses as well as bacteria. (False, reverse code)	44.0%
The center of the earth is very hot. (True)	77.5%
All radioactivity is manmade. (False, reverse code)	63.8%
The oxygen we breathe comes from plants. (True)	76.7%
All insects have eight legs. (False, reverse code)	68.9%
Men and women normally have the same number of chromosomes. (True)	54.7%
The continents have been moving their location for millions of years and will continue to move. (True)	79.7%
Lasers work by focusing sound waves. (False, reverse code)	37.0%
Electrons are smaller than atoms. (True)	62.4%
All plants and animals have DNA. (True)	69.7%
Negative emotion (scale 1–5)	**Score 4–5, agree- strongly agree**
Sadness	49.6%
Fear	44.1%
Anger	40.4%
Shock	58.4%

Science knowledge

It is important to measure the objective science knowledge of individuals rather than their perceived science knowledge because extremists in science topics tend to overestimate their knowledge.[31] To measure objective science knowledge, we selected 10 of the 15 items from Fernbach et al.'s[32] scales of scientific literacy. Respondents were asked whether the 10 statements were correct or not. We added up the number of correct answers to form the science knowledge index ($M = 2.74$, $SD = 0.38$).

Negative emotion

By adapting Yeung and Fung's (2007)[31] measures of emotional responses, participants were asked to rate the levels of 'sadness', 'fear', 'anger' and 'shock' in response to COVID-19 on a 5-point Likert scale (1 = not at all, 5 = very intensive). The items were averaged for each respondent as an indicator of negative emotion ($\alpha = 0.85$, $M = 3.47$, $SD = 1.08$).

Control variables

Respondents were also asked to report their age, gender, education, income, region of residence and Internet use frequency. For Internet use, respondents were asked how often they use the desktop and mobile devices to access the Internet, from 1 'never' to 5 'always'. The average scores of these two items formed the index of Internet use ($\alpha = 0.69$, $M = 4.24$, $SD = 0.78$).

Analysis

To analyze the data, a series of ordinary least squares (OLS) linear regression analyses were performed with SPSS version 26.0. We first tested a model with demographic and control variables only, as a baseline model. Then, the key independent variable fact-check habit and the two moderators (i.e. science knowledge and negative emotion) were entered into the model sequentially. Finally, we explored the moderation effects by including interaction terms in the regression equations.

Results

Before formal analysis, we checked the sample representativeness of our data. The demographic information is summarized in Table 1. The distributions of demographic variables (age, gender, education, and income) of the sample are very close to those reported in the 44th CNNIC report,[28] which is also shown in Table 1.

The descriptive statistics of the main variables were also checked (see Table 2). The majority of respondents (70.5%) knew that the statement 'Drinking alcohol won't reduce coronavirus risk' was false. However, only 51.8% of respondents knew that the following statement was true: 'The coronavirus lasts longest on the smooth, non-porous surface; thus, the virus survives shorter on a sweater than the metal surface'. The accuracy rates of science knowledge items ranged from 44.0% to 79.7%. In terms of emotional reactions to the pandemic, more respondents felt shocked (58.4%) than fear (44.1%), sadness (49.6%) or anger (40.4%). In general, the likelihood of fact-checking was reasonable (see Table 2). More than half of the respondents reported that they were likely to fact-check online information by checking major news outlets and using the search engine. About a half would perform fact-check by asking friends or family members and checking social media, such as Weibo and WeChat. We also examined the diversity of fact-checking strategies. The percentages of people who are 'likely' or 'very likely' to perform one, two, three, or four types of fact-checking strategies when reading

Table 3
Regression analysis: predicting COVID-19 knowledge.

COVID-19 knowledge						
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Age	.14*** [.01,.02]	.05* [.00,.01]	.02 [-.00,.01]	.02 [-.00,.01]	.02 [-.00,.01]	.02 [-.00,.02]
Gender	-.02 [-.17,.04]	-.02 [-.16,.03]	-.03 [-.16,.02]	-.02 [-.14,.04]	-.02 [-.14,.03]	-.02 [-.15,.02]
Education	.06** [.02,.12]	.03 [-.01,.08]	.04 [-.00,.08]	.04* [-.00,.09]	.04* [.00,.09]	.03* [.00,.08]
Income	.04* [.00,.11]	.04* [.01,.12]	.04* [.00,.10]	.04* [.00,.10]	.03* [.00,.10]	.04* [.01,.10]
Residence	.01 [-.09,.13]	-.00 [-.11,.10]	-.03 [-.17,.03]	-.01 [-.13,.06]	-.01 [-.13,.07]	-.01 [-.13,.06]
Internet use	.06** [.04,.17]	.20*** [.30,.44]	.10*** [.12,.25]	.13*** [.17,.29]	.014*** [.18,.31]	.13*** [.18,.31]
FCH	–	-.36*** [-.66,-.53]	-.29*** [-.53,-.41]	-.20*** [-.39,-.27]	-.21*** [-.41,-.28]	-.22*** [-.43,-.31]
SK	–	–	.36*** [1.24,1.48]	.32*** [1.09,1.34]	.32*** [1.10,1.35]	.31*** [1.05,1.30]
NE	–	–	–	-.23*** [-.34,-.25]	-.22*** [-.34,-.25]	-.21*** [-.33,-.24]
FCH*SK					.05** [.09,.37]	–
FCH*NE	–	–	–	–		-.12*** [-.21,-.13]
R^2(%)	2.2***	12.4***	24.0***	28.1***	28.4***	29.5***

Note: The table shows standardized coefficient beta, with a 95% confidence interval in brackets.
The interaction terms have been centered.
*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.
FCH, fact-checking habit; NE, negative emotion; SK, science knowledge.

online information are 13.2% (n = 242), 17.2% (n = 315), 15.3% (n = 281), and 14.4% (n = 265), respectively. One in five respondents (21.5%, n = 395) reported that they were ‘likely’ or ‘very likely’ to adopt all of the fact-checking strategies; however, 18.5% (n = 338) of respondents reported no intention to use any of the examined fact-checking strategies when reading online information.

The regression results are shown in Table 3. Among the control variables, age ($b = 0.14$, 95% confidence interval [CI] = 0.01–0.02, $P < 0.001$), education level ($b = 0.06$, 95% CI = 0.02–0.12, $P < 0.01$), and income ($b = 0.04$, 95% CI = 0.00–0.11, $P < 0.05$) all have positive effects on the obtainment of COVID-19 knowledge. Individuals who use the Internet ($b = -0.15$, 95% CI = 0.04–0.17, $P < 0.001$) know more about COVID-19 than those who do not use the Internet. However, fact-checking was negatively related to the obtainment of COVID-19 knowledge ($b = -0.36$, 95% CI = −0.66–0.53, $P < 0.001$).

The relationship between fact-checking habit and obtainment of COVID-19 knowledge depends on the levels of science knowledge ($b = 0.05$, 95% CI = −0.34–0.25, $P < 0.01$). Science knowledge had a direct effect on susceptibility to misinformation ($b = 0.36$, 95% CI = 1.24–1.48, $P < 0.001$). The interaction effect is shown in Fig. 1. For people with high science knowledge, their experience of fact-checking barely changed their knowledge about COVID-19. However, for people with less science knowledge, people who fact-check frequently obtained less COVID-19 knowledge.

Negative emotion also moderated the impact of fact-checking habit on COVID-19 knowledge ($b = -0.12$, 95% CI = −0.21–0.13, $P < 0.001$). Results also showed that negative emotion toward the pandemic had a negative effect on COVID-19 knowledge ($b = -0.23$, 95% CI = −0.33–0.24, $P < 0.001$). The interaction effect is shown in Fig. 2. However, contrary to our hypothesis, for people with more negative emotion, knowledge about COVID-19 dropped significantly if they fact-check more. Among those who had a high level of negative emotion, COVID-19 knowledge decreased slightly as their fact-checking experience increased.

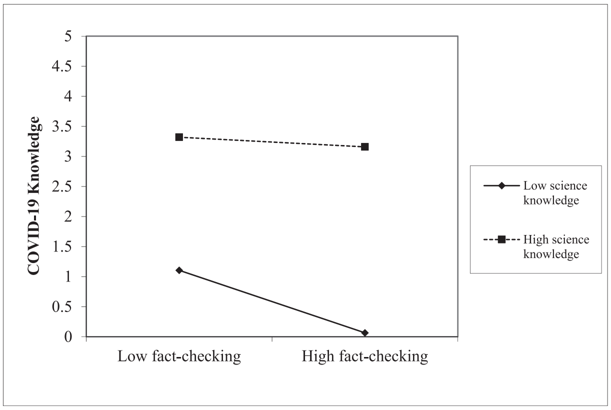

Fig. 1. Interaction effect of fact-checking habit and science knowledge on COVID-19 knowledge.

Discussion

Previous studies suggest that if individuals perform fact-checking on the information they consume, they are more likely to obtain knowledge.[13] Our findings suggest the opposite in the context of the COVID-19 pandemic: people may not be able to obtain high-quality information, even if they have a good fact-checking habit, and especially when they lack knowledge about science or were influenced by negative emotion.

First, fact-checking habit had a negative relationship with COVID-19 knowledge. There are several possible explanations for this result. First, the new coronavirus brings a new health crisis to the world. When the virus swept through China, lots of unverified information about the virus appeared on the Internet, while scientists and health departments were still striving to understand the virus. Therefore, when facts are missing, the habit of fact-checking does not necessarily help to identify the useful knowledge. Second, people tend to

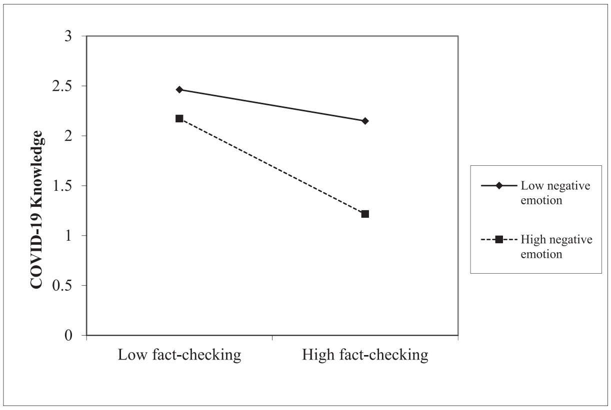

Fig. 2. Interaction effect of fact-checking habit and negative emotion on COVID-19 knowledge.

fact-check what they believe for confirmation.[30] Meanwhile, it is more difficult to counter wrongful beliefs when individuals have accepted them, which is called the continued or persistent effect of inaccurate information.[33,34] According to the cognitive bias theory, people prefer messages that are in line with their prior beliefs and resist the opposite.[35] Thus, if people have accepted a wrongful idea, pre-existing bias will make people less likely to obtain the facts about COVID-19, even if they fact-check what they read from the Internet. Third, even if people fact-check without the influence of pre-existing beliefs, the information environment they are facing may not allow them to encounter diverse opinions. The Internet, especially social media, makes it easier for individuals to block voices of opposing opinions and selectively expose themselves to information that supports their views.[36,37] Fact-checking in a homogenous information environment or social network keeps people away from information they need.

This study further examined whether the effects of fact-checking habit on knowledge obtainment depend on existing science knowledge and negative emotion. The result is largely consistent with the Matthew effect of literacy acquisition.[19] The data showed that people with less science knowledge gain less knowledge about COVID-19 as their experience of fact-checking increases. Among people with high science knowledge, COVID-19 knowledge barely changed with fact-checking habit. The finding highlights the importance of early science education in increasing the likelihood of knowledge intake. However, many reports demonstrated the difficulties in promoting science education. Although both developed and developing countries see the necessity of science education, there are so many challenges and problems, such as declining interest in science studies, inequality in teaching recourses and insufficient family involvement.[38,39]

Among people who hold more negative emotion toward the pandemic, their fact-checking habit decreases the likelihood of knowledge obtainment. The finding implies that mental health is important in knowledge obtainment during a health crisis. Recent studies show that the problem of negative emotion during the pandemic is commonly seen. A study in China showed that young people suffer more from anxiety disorders and depressive symptoms than older age groups, and healthcare workers have the highest rate of poor sleep quality.[40] In addition, a study in the United States found depression skyrocketed during the COVID-19 pandemic among adults.[41] Therefore, healthcare departments and organizations should pay more attention to mental health issues within the population during the pandemic given its potential to influence knowledge gain.

It is important to point out the limitations of this study. First, the fact-checking measurement scale[30] adopted by this study did not capture all aspects of fact-checking behavior and excluded some unmeasured fact-checking strategies that people have been shown to use.[14] Therefore, developing a comprehensive scale for fact-check behavior could benefit similar research endeavors in the future. Second, because this study was conducted during the COVID-19 pandemic, and people were not very likely to hold a positive emotion toward the pandemic, it only examined the effects of negative emotions. Future studies can examine the effects of positive emotions on fact-checking and knowledge gain. Third, future studies should further explore the mechanisms behind information verification and the obtainment of science knowledge. Information sources and trust in these sources might also play an important role.[42,43]

In conclusion, this study has two main findings. First, we found a negative relationship between fact-checking habit and the levels of COVID-19 knowledge during the pandemic. This result indicates that encouraging fact-checking behaviors might not be an effective solution to fighting an infodemic. Governments, the media, and non-governmental organizations (NGOs) should directly engage in promoting scientific health knowledge instead of encouraging people to fact-check in a low-quality information environment. Second, this study sheds light on the practice of knowledge promotion by suggesting that a lack of general science knowledge and increased negative emotion can lead to less knowledge obtainment, even if they are active in information fact-checking. To promote health knowledge during a public health crisis, basic science literacy must be promoted and the psychological impact of the crisis on the population must also be considered. In the long run, science literacy education is important to alleviate the inequality in health knowledge obtainment.

Author statements

Ethical approval

This study was approved by the Institutional Review Board of Fudan University.

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Competing interests

None declared.

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Effects of Zentangle art workplace health promotion activities on rural healthcare workers

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ABSTRACT

Objectives: Workplace health promotion activities have a positive effect on emotions. Zentangle art relaxes the body and mind through the process of concentrating while painting, achieving a healing effect. This study aimed to promote the physical and mental health of rural healthcare workers through Zentangle art–based intervention.
Study design: This was a quasi-experimental pilot study.
Methods: A Zentangle art workshop was held from November 2019 to July 2020. A total of 40 healthcare workers were recruited. The participants were asked to provide baseline data, and the Brief Symptom Rating Scale (BSRS-5), work stress management effectiveness self-rating scale, General Self–Efficacy Scale (GSES), and Workplace Spirituality Scale (WSS) were administered before and after the workshop. SPSS 22.0 statistical package software was used to conduct the data analysis.
Results: The median age (interquartile range [IQR]) was 32.00 years (23.00–41.75 years). The Wilcoxon signed-rank test revealed that the median (IQR) BSRS-5 postintervention score was 4.0 (1.25–5.0), which was lower than the preintervention score ($P = 0.004$). The postintervention score for the work stress management effectiveness self-rating scale was 36.5 (31.0–40.0), which was also lower than the preintervention score ($P = 0.009$). A higher score for the GSES or WSS indicated improvements in stress management and self-efficacy. The GSES postintervention score 25.00 (21.0–30.75) was significantly higher than the preintervention score ($P = 0.010$), and the WSS postintervention score 104.0 (88.0–111.75) was significantly higher than the preintervention score ($P = 0.005$).
Conclusions: The study provides evidence that painting therapy can effectively relieve stress, reduce workplace stress and frustration, enhance self-efficacy, and increase commitment to work among healthcare workers, thus improving their physical, mental, and spiritual well-being. Zentangle art provides employees with multiple channels for expressing their emotions and can improve the physical and mental health of healthcare workers in the workplace. It is beneficial and cost-effective and can serve as a benchmark for peer learning.

Introduction

The World Health Organization emphasizes the importance of a safe, healthy, and supportive work environment.[1] Workplace organizational health promotion, health behavior change, and environmental protection measures can promote the physical,

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psychological, economic, and social welfare of employees, which in turn indirectly affects the health of families, communities, and society.[1] Medical resources in remote areas and outlying islands are generally inadequate compared with other areas because of transportation issues, scattered and sparse populations, difficulty in recruiting healthcare workers, and lack of healthcare accessibility.[2] According to the Ministry of Health and Welfare (MOHW), 50% of the world's population live in remote areas, but only 38% of nursing staff and less than 25% of physicians work in those areas,[3,4] highlighting the shortage of healthcare workers and uneven distribution of resources.[5] Rural healthcare workers are faced with heavy workloads and frequent patient complaints, resulting in negative emotions and work-related stress, which can easily lead to greater psychological distress and more physical and mental health risks.[3,6,7]

Workplace health is a concern for healthcare workers, who are often exhausted in the workplace.[8] Work-related stress, compounded by environmental, organizational, and personal factors, causes negative emotions and physical stress,[9] which affects work performance, absenteeism, and can lead to physical and psychological problems, including multiple illnesses.[3,6] Workplace spirituality is defined as a workplace that recognizes that employees have an inner life that nourishes and is nourished by meaningful work that takes place in the context of community.[10] Workplace spirituality examines the workplace atmosphere and interpersonal relationship with peers and supervisors. It is strongly implicated in the well-being of an individual, organization, and society as a whole.[10] In addition, if an organization is committed to improving the physical and psychological well-being of employees, it can aid in decreasing the probability of employees becoming sick, the incidence of workplace injury, and medical costs.[10–13] It has been suggested that workplace spirituality has an indirect or direct effect on the self-efficacy, work-related stress, and psychological distress of healthcare workers.[8] Workplace spirituality positively affects the medical workplace environment, which is interconnected and requires high degrees of trust and motivation to move forward through cooperation.[8] Moreover, workplace spirituality enables employees to develop and reach their full potential and also directly aids them in tackling the problems that arise from work-life conflicts. In this way, employees demonstrate positive work attitudes, and their self-efficacy and positive thinking are advanced.[7,9,14] Self-efficacy is defined as people's attitudes toward adversity, their perception of stress, and their ability to regulate the stress they endure when facing difficulties, which has a direct influence on stress.[15]

An increasing number of people are now seeking alternative and complementary treatments to cope with life and seek relief. Among them, art therapy is a clinical intervention that has been effectively used to improve quality of life since the early 1990s, whereby the expressive power of artistic creation is used to increase physical, psychological, and emotional well-being.[16] Art therapy intervention enables healthcare workers to rejuvenate and refocus and provides an outlet for them to express themselves and gain a sense of personal accomplishment through the creative process.[17] Zentangle art is a non-verbal form of drawing that enables people to contemplate and meditate by creating pictures. ‘Zen’ itself represents meditation, slowing down to feel and cherish everything in front of us; and ‘tangle’ represents a form of art to construct a picture one stroke at a time while engaging the participant in a dialog with him/herself by calming his/her mind.[18] Zentangle art uses non-representational, unplanned, and structured pattern drawing to enter a state of mindfulness. With nature and the objects around us as prototypes, Zentangle art uses simple, basic, and repetitive lines and shapes to fill space and extend arbitrarily in any direction, creating beautiful patterns. The method is easy to learn, and anyone can create at any time and any place. Zentangle art can be used for stress reduction, education, therapy, and even motivation training, which includes calming an anxious mind, increasing self-confidence, and cultivating moment-to-moment awareness in a similar manner to mindfulness meditation.[19,20]

In a medical environment with a high risk of infectious disease, the physical and mental health needs of rural healthcare workers should be a top priority. Workplace health promotion activities have a positive effect on mood, and art therapy can be used as a tool for relieving stress and improving well-being. Therefore, this study aimed to promote physical and mental health among a group through a Zentangle drawing/painting intervention.

Methods

Study design

This was a one-group pretest-posttest quasi-experimental pilot study, in which all the participants received the treatment (without a control group).

Setting and sample

This study was conducted from November 2019 to July 2020, in collaboration with the nursing department of a regional hospital in Pingtung County. Forty healthcare workers were recruited to participate in a Zentangle art workshop. The inclusion criteria were as follows: healthcare workers of the hospital who were willing to participate in the Zentangle art workshop and who agreed to respond to the questionnaire.

Ethical considerations

This study was approved by the Institutional Review Board of Kaohsiung Veterans General Hospital, and the ethical principles of biomedical science were strictly adhered to during questionnaire collection. Before data collection, the aim and procedures of the study were explained, and subjects were informed that all questionnaires were anonymous. Thus, the data and information could not be used to identify the subjects and were strictly confidential.

Measurements

The research tool in this study was a structured questionnaire, including a baseline information form, the Brief Symptom Rating Scale (BSRS-5), the work stress management effectiveness self-rating scale, the General Self–Efficacy Scale (GSES), and the Workplace Spirituality Scale (WSS).

1. **Baseline data information form.** The baseline data information form was used to collect data on age, gender, education level, economic condition, marital status, and seniority.
2. **Brief Symptom Rating Scale.** The BSRS-5 was developed by Professor Ming-Pin Lee from the Department of Psychiatry at National Taiwan University and others using the Symptom Check List-90-Revised developed by Derogatis. The scale consists of five items that measure the following psychological symptoms: anxiety (feeling nervous or tense), depression (feeling frustrated or depressed), hostility (feeling upset or annoyed easily), low self-esteem (feeling inferior to others), and sleep disturbance (inability to sleep in the past week). Each item was self-rated on a scale of 0–4. The total score ranges from 0 to 20, with higher scores indicating greater severity of psychological distress. The internal consistency (Cronbach's alpha) of the BSRS-5 ranged from 0.77 to 0.90.[21]

3. **Work stress management effectiveness self-rating scale.** The scale was provided by the Taiwan Association against Depression.[22] It consists of 20 questions with responses measured on a five-point Likert scale. Participants were required to choose an answer that best suited their own situation according to each description, with higher total scores indicating greater work stress.
4. **General Self-Efficacy Scale.** The Chinese version of the GSES developed by Jerusalem and Schwarzer was adopted, with a total of 10 questions measured by a four-point Likert scale. Participants were required to choose an answer that best suited their own situation according to each description, with higher total scores indicating greater self-efficacy and self-confidence as well as positive mood. The internal consistency was Cronbach's $\alpha = 0.887$, and the retest reliability was 0.83. In terms of validity, the correlation between the 10 items of the GSES and the total score of the scale was between 0.60 and 0.77.[23]
5. **Workplace Spirituality Scale (WSS).** The scale was translated by Li Junta and Huang Chaomeng[10] from the questionnaires developed by Duchon and Plowman[11] and Houston and Cartwright.[12] The scale consists of 28 questions in four dimensions. Dimensions 1–3 were inner life, meaningful work, and sense of group belonging as proposed by Duchon and Plowman,[11] whereas Dimension 4 was a relationship with God as discussed by Houston and Cartwright.[12] A five-point Likert scale was used, with higher scores indicating deeper commitment to work and positive effect. The internal consistency of the questionnaire was 0.822, 0.864, and 0.857, in previous studies.[10,24]

Intervention

Zentangle was founded in 2004 by Rick Roberts and Maria Thomas in the United States.[17] The Zentangle-certified teacher system has been introduced in many countries/regions (Central Zentangle Method, n.d.[25]). The purpose of Zentangle art was not to develop a new art form but to develop a method of meditating through artistic means. Some important principles of Zentangle art include ‘one stroke at a time’, ‘no eraser’, ‘abstract’, ‘inspiring’, and ‘free expression’, thereby being a form of spiritual catharsis and sedation. Zentangle art aims for the drawer to take pleasure in the joy of drawing but also to gradually eliminate anxiety and stress through concentration and natural emptiness. This produces calming therapeutic effects and feelings of pleasure and relaxation, leading to a state of meditative pleasure.[19,25]

The research intervention was conducted in the form of a Zentangle art workshop, comprising two groups of 20 healthcare workers participating in just one workshop of 4 h including/involving five parts. The workshop instructors were Certified Zentangle Teachers (CZT®) who had undergone training, and all courses were delivered using the same model. Before the start of the workshop, each participant received materials required for Zentangle art, including black technical pens, white paper, and Zentangle white paper tiles (official product), which they could keep to draw anytime and anywhere after the end of the course to express unpleasant feelings. The Zentangle art workshop process is shown in the Supplement Table.

Main research variables

Main research variables included (1) age, (2) work shift, (3) education level, (4) on-the-job training, (5) marital status, (6) economic condition, (7) residential situation, (8) religiosity, (9) BSRS-5 (10) work stress management effectiveness self-rating scale (11) GSES, and (12) workplace spirituality score.

Statistical analysis

Normally distributed data were expressed as mean and standard deviation, abnormally distributed data as median and IQR, and category data as frequency and proportion. Shapiro–Wilk test (Altman, 1991) was used to test the normality, and the results of this study did not follow the normal distribution. Therefore, the Wilcoxon signed-rank test was used to compare pretest- and posttest-derived effectiveness, and $\chi 2$ goodness-of-fit tests were used to compare the study sample with the parent population. The significance level was set at <0.05. Data were analyzed using the SPSS version 22.0 (IBM Corporation, Armonk, NY, USA).

Results

This study examined the representativeness of the sample in a rigorous manner. The suitability test revealed no significant difference in age between the sample and the parent population (all nursing staff of the hospital; $P = 0.981$). Conversely, there was a significant difference in seniority between the two ($P = 0.000$); 55% of the sample had less than 1 year of seniority, compared with 12.42% in the parent population. This difference could be attributed to the high turnover rate of nursing staff, leading to the lower seniority of the cases in this study (Table 1). Table 2 depicts the characteristics of the sample. Forty healthcare workers with a median age (interquartile range [IQR]) of 32.00 (23.00–41.75) years were surveyed; 27 work shifts, 28 were university educated, six undertook on-the-job training, 26 were unmarried, 27 had good economic status, 33 were living with others, and 27 held religious or spiritual beliefs.

Table 3 shows the Wilcoxon signed-rank test results comparing the pre- and post-intervention data on the four scales. Lower BSRS-5 and work stress management effectiveness self-rating scale scores indicated improvements in mental well-being. The median (IQR) BSRS-5 postintervention score was 4.0 (1.25–5.0), which was lower than the preintervention score of 4.0 (2.0–6.0; $P = 0.004$). The postintervention score for the work stress management effectiveness self-rating scale was 36.5 (31.0–40.0), which was also lower than the preintervention score of 38.5 (32.25–45.0; $P = 0.009$). Higher GSES indicated more self-efficacy, and higher WSS scores indicated more workplace spirituality. The GSES postintervention score of 25.00 (21.0–30.75) was significantly higher than the preintervention score of 24.0 (20.25–26.0; $P = 0.010$), and the WSS postintervention score of 104.0 (88.0–111.75) was significantly higher than the preintervention score of 97.0 (86.0–107.0; $P = 0.005$). Fig. 1 shows the box-and-whisker plots of the four scales.

Discussion

To the best of our knowledge, this is the first study to investigate the physical and mental health of rural healthcare workers using Zentangle art therapy as an intervention. Through pre- and posttest questionnaires, it was discovered that Zentangle art activities could reduce the psychological distress and work stress of rural healthcare workers and enhance their self-efficacy and workplace spirituality.

According to a MOHW survey on 480 hospitals in 2018, there was a 10% turnover rate and a 4.5% vacancy rate among healthcare workers.[26] The survey also found that rural hospitals had difficulty recruiting nursing staff and that the turnover and vacancy rates in rural areas were higher than those in other areas in Taiwan. It is estimated that the elderly population will increase to 5.59 million by 2030 (an increase of 63.1%). This will lead to an increase in the demand for health care in a super-aged society, and medical

Table 1
Tests of goodness-of-fit between sample and parent population by age and seniority.

Variables	Parent population (N = 161)	Sample (N = 40)	χ2	*P* value
	n (%)	n (%)		
Age (y)			0.001	0.981
20–40	118 (72.67)	29 (72.5)		
>41	40 (27.33)	11 (27.5)		
Job tenure (y)				
<1	20 (12.42)	22 (55.0)	68.05	0.000
1–5	68 (42.24)	6 (15.0)		
6–10	33 (20.50)	7 (17.5)		
>10	40 (24.84)	5 (12.5)		

Table 2
Characteristics of the sample.

Characteristics	*N* = 40[a]
Age	32.00 (23.00–41.75)
Supervisor	
Yes	1 (2.5)
No	39 (97.5)
Work shift	
Yes	27 (67.5)
No	13 (32.5)
Education level	
College	12 (30.0)
University	28 (70.0)
On-the-job training	
Yes	6 (15.0)
No	34 (85.0)
Marital status	
Married	14 (35.0)
Single	26 (65.0)
Economic condition	
Low income	5 (12.5)
Median income	27 (67.5)
High income	8 (20.0)
Residential situation	
Living with other people	33 (82.5)
Living alone + others	6 (15.0)
Religiosity	
Yes	27 (67.5)
No	13 (32.5)

[a] Values are represented as median (interquartile range) or number (proportion).

manpower will be concentrated in highly developed areas, resulting in a more uneven distribution of medical manpower in rural areas.[27] Similarly, Asante et al.[6] argue that in addition to inadequate resources in rural areas, working under harsh conditions such as limited opportunities for promotion, heavy workloads, overtime, and limited resources, ultimately causes impaired efficiency, decreased well-being, work stress, and negative health effects among healthcare workers. Therefore, the issue of nursing manpower in rural areas is a priority health and medical policy.[2]

The creation of art extends in any direction arbitrarily. Through the process of painting, one feels calm and enters into contemplation and meditation; through concentration and natural release, anxieties and stress can be relieved, and one can enter a state of meditation and pleasure.[28,29] In the present study, the healthcare workers in Pingtung County received Zentangle art therapy. The BSRS-5 and the work stress management effectiveness self-rating scale were adopted to learn about their mood and psychological care needs, and the results suggested that psychological distress and work stress were relieved. Similar to the findings of Tjasink and Soosaipillai,[17] participants were required to attend art therapy sessions with an art therapist, and a questionnaire was used to learn about changes in healthcare workers. Art therapy was found to raise awareness of symptoms of mental health problems and to be more flexible in managing the stress. Karpavičiūtė and Macijauskienė[28] also revealed that participating in art therapy had a positive effect on work stress and that the participants in the intervention group were able to relax after work and their sense of tension was reduced. Art therapy allows healthcare workers to produce calming, healing effects and pleasant, relaxing feelings, serving as a channel for emotional release. Wilson et al.[30] suggested that holding art activities in medical institutions can relieve stress, lift mood, improve work performance, reduce burnout, strengthen patient–staff relations, and improve the workplace environment and work effectiveness.

The level of group cooperation and organization in the workplace is of paramount importance.[31] When a member of an art therapy group describes their work and shares with the group, this often arouses the emotional responses and past experiences of other members, enhancing interaction and cohesion among the group members. This, in turn, has a self-healing effect, which also cultivates self-esteem and self-awareness, fosters emotional adaptation, promotes insight, and increases social interaction skills.[16] Poor work environment and status affects an individual's self-efficacy and leads to negative effects on health and emotion.[32] Higher self-efficacy has been shown to reduce negative emotions associated with work stress, interpersonal conflict, and frustration

Table 3
Work-related stress, self-efficacy, workplace spirituality, and emotion management pre- and post-intervention.

Variables		Median	IQR 1	IQR 3	Minimum to Maximum	*P* value[a]
BSRS-5	Preintervention	4.00	2.00	6.00	0.00–14.00	0.040
	Postintervention	4.00	1.25	5.00	0.00–11.00	
Work stress management effectiveness self-rating scale	Preintervention	38.50	32.25	45.00	24.00–71.00	0.009
	Postintervention	36.50	31.00	40.00	20.00–69.00	
GSES	Preintervention	24.00	20.25	26.00	12.00–34.00	0.010
	Postintervention	25.00	21.00	30.75	15.00–40.00	
Workplace spirituality	Preintervention	97.00	86.00	107.00	66.00–140.00	0.005
	Postintervention	104.00	88.00	111.75	66.00–140.00	

IQR, interquartile range; BSRS-5, Brief Symptom Rating Scale-5; GSES, General Self–Efficacy Scale.
[a] Wilcoxon signed-rank test.

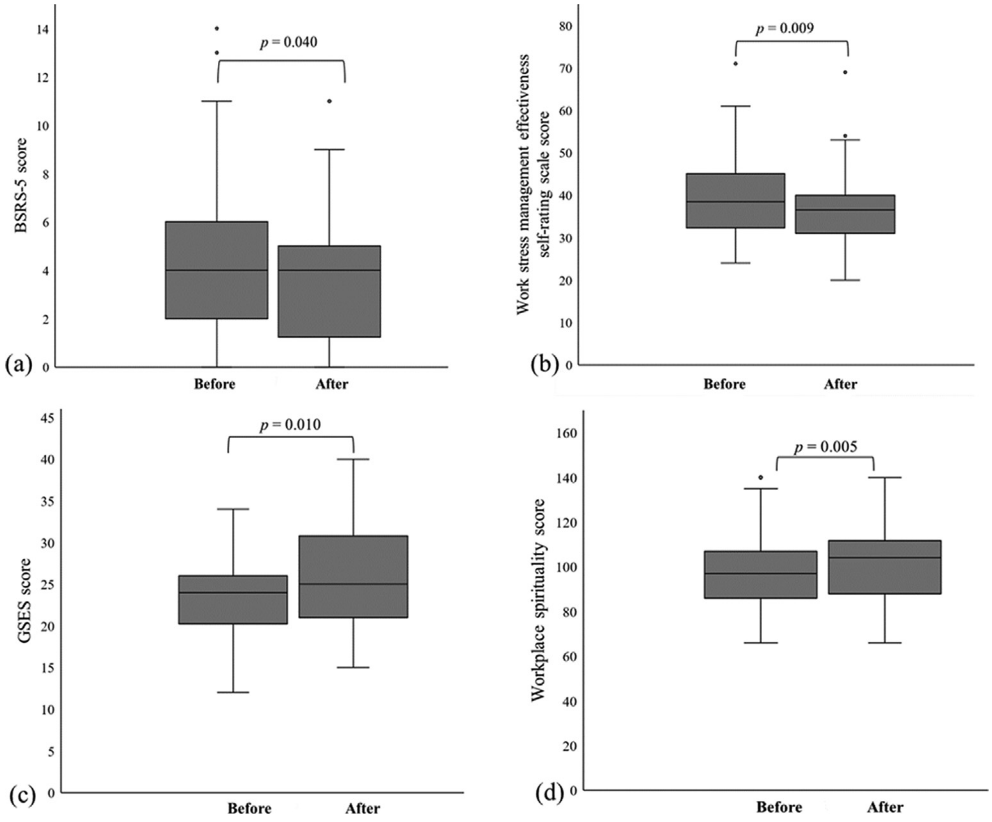

Fig. 1. Box-and-whisker plots showing (a) Brief Symptom Rating Scale-5 scores (BSRS-5), (b) work stress management effectiveness self-rating scale, (c) General Self–Efficacy Scale scores (GSES), and (d) workplace spirituality scores for both the pre- and post-intervention periods. Horizontal lines are medians, boxes are interquartile ranges, and whiskers are ranges.

and to improve one's ability to solve problems.[32] In the present study, the increase in workplace spirituality made the healthcare workers feel that their work had more meaning, and they experienced a greater sense of belonging, which led to better work performance. Self-efficacy was found to have positive and significant influence, echoing the Zentangle art process of not using an eraser and not emphasizing right and wrong, but instead learning to correct, make up for, or accept what is wrong in life and encouraging honest acceptance of oneself and reality. Raising positive thinking and self-understanding through Zentangle art leads to higher levels of self-efficacy.[33] Self-efficacy is not only a belief or judgment but also a cognitive, motivational, and behavioral choice.[32] Karpavičiūtė et al.[28] argued that bringing art activities into the workplace can promote work health, reduce work stress, enhance interorganizational communication, and even increase group consciousness of healthcare workers, thereby raising self-esteem.

Implications

To narrow the medical gap between urban and rural areas and to improve the health of the whole population, the government has advocated the construction of a localized, continuous, and integrated public health and medical service system.[27] Healthcare workers play a vital role in patient care. If there is a shortage of medical recruits, they have to work more overtime or reduce the number of beds, which affects their quality of life and the quality of health care.[10] Zentangle art enables the participants to focus on calm feelings, seek positive emotions and life energy, and achieve the desired peace of mind and stability in a calm and tranquil state of mind.[16] This study suggests that Zentangle art can be integrated into the workplace as a physical, mental, and spiritual health promotion care activity to relax the body and mind and reduce stress. Zentangle art is easy to use and is not limited by time, location, or materials.

Study limitations and scope of future studies

This study is limited in three ways. First, the study had a small sample size with relatively young participants because of the rural location and the high turnover rate of nurses although we confirmed that the sample size was representative of the parent population in terms of age. Second, the study did not have a control group. Third, the participants in this study only attended one workshop, and to sustain the therapeutic effect, multiple rounds of intervention may be required. Therefore, further studies on a large sample size with wider age groups and an appropriate control are warranted. Furthermore, we will also use qualitative research methods in future studies to examine the mechanisms of meditative art-based mindful practices. These future study designs, especially when significant positive results are produced, may further increase the rationale for institutional funding to support the implementation of and sustain meditative art-based interventions, thereby creating a more positive and supportive workplace for healthcare workers.

Conclusions

Zentangle art therapy can relieve the psychological distress and work stress of rural healthcare workers and enhance their self-efficacy and spirituality. Drawing therapy enables healthcare workers to relieve stress, reduce stress and frustration in the workplace, increase workplace attractiveness, and enhance self-efficacy. This leads to improvements in work performance, which in turn enhances physical, mental, and spiritual care. Zentangle art provides employees with multiple channels to express their emotions, is an effective and cost-effective method, and serves as a benchmark for peer learning. However, further studies on a large sample size with comprehensive designs are needed.

Author statements

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Ethical approval

This study was approved by the Institutional Review Board of Kaohsiung Veterans General Hospital, and the ethical principles of biomedical science were strictly adhered to during questionnaire collection. Before data collection, the aim and procedures of the study were explained, and subjects were informed that all questionnaires were anonymous. Thus, the data and information could not be used to identify the subjects and were strictly confidential.

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Competing interests

None declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2021.05.033.

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Original Research

Estimating COVID-19 recovery time in a cohort of Italian healthcare workers who underwent surveillance swab testing

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ABSTRACT

Objectives: The COVID-19 pandemic is putting a huge strain on the provision and continuity of care. The length of sickness absence of the healthcare workers as a result of SARS-CoV-2 infection plays a pivotal role in hospital staff management. Therefore, the aim of this study was to explore the timing of COVID-19 recovery and viral clearance, and its predictive factors, in a large sample of healthcare workers.
Study design: This is a retrospective cohort study.
Methods: The analysis was conducted on data collected during the hospital health surveillance programme for healthcare staff at the University Hospital of Verona; healthcare workers were tested for SARS-CoV-2 through RT-PCR with oronasopharyngeal swab samples. The health surveillance programme targeted healthcare workers who either had close contact with SARS-CoV-2–infected patients or were tested as part of the screening-based strategy implemented according to national and regional requirements. Recovery time was estimated from the first positive swab to two consecutive negative swabs, collected 24 h apart, using survival analysis for both right-censored and interval-censored data. Cox proportional hazard was used for multivariate analysis.
Results: During the health surveillance programme, 6455 healthcare workers were tested for SARS-CoV-2 and 248 (3.8%, 95% confidence interval [CI]: 3.4–4.3) reported positive results; among those who tested positive, 49% were asymptomatic, with a median age of 39.8 years, which is significantly younger than symptomatic healthcare workers (48.2 years, $P < 0.001$). Screening tests as part of the health surveillance programme identified 31 (12.5%) of the positive cases. Median recovery time was 24 days (95% CI: 23–26) and 21.5 days (95% CI: 15.5–30.5) in right- and interval-censoring analysis, respectively, with no association with age, sex or presence of symptoms. Overall, 63% of participants required >20 days to test negative on two consecutive swabs. Hospitalised healthcare workers (4.8%) were older and had a significantly longer recovery time compared with non-hospitalised healthcare workers in both analyses (33.5 vs 24 days, $P = 0.005$).
Conclusions: Recovery from COVID-19 and viral clearance may take a long time, especially in individuals who are hospitalised. To detect asymptomatic cases, screening programmes for healthcare workers is recommended.

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Introduction

SARS-CoV-2 is a new single-stranded RNA coronavirus, first identified in Wuhan, China, in December 2019, and it is responsible for the onset of coronavirus disease 2019 (COVID-19) in humans.[1,2] The most common clinical presentation of severe COVID-19 is acute respiratory distress syndrome, while many people report mild symptoms, such as fever, cough and coryza. Some cases of COVID-19 are fully asymptomatic;[3] however, the exact percentage of asymptomatic cases remains uncertain.[4]

Italy is among the countries that has been worst hit by the coronavirus pandemic, with 3,920,945 total cases and 118,357 deaths (data last updated 22 April 2021).[5] Veneto, where the University Hospital of Verona is located, has the second most numerous cases among the Italian regions (405,031 total cases and 11,183 deaths).[5]

The COVID-19 pandemic has proved to be a challenge for healthcare systems around the world and, although many ongoing studies are making a valuable contribution in understanding this new infection, many issues remain unresolved. Criteria to safely readmit SARS-CoV-2–infected individuals into the community are still debated.[6,7] Healthcare workers (HCWs) are a particular subset of the general population that may acquire SARS-CoV-2 as an occupational infection. Special attention should be paid to plan their re-integration into the workplace, as they may transmit the infection to patients, other HCWs or visitors.[8] One of the main problems with SARS-CoV-2–infected HCWs is finding the right balance between the necessity to isolate until viral clearance and returning to work to ensure the continuity of care for patients.[9]

Up to October 2020, in Italy, a SARS-CoV-2 patient was considered to have recovered and to no longer be infectious following two negative tests, together with the complete resolution of the signs and symptoms of COVID-19.[10,11] Whereas, a 14-day self-quarantine was recommended for untested individuals who had close contact with a SARS-CoV-2–infected case. However, it is still unclear what actual timespan is required for an individual to reach viral clearance and to no longer be considered infectious. The aim of this study was to explore the timing of COVID-19 recovery and viral clearance, and its predictive factors, in a large sample of HCWs.

Methods

A retrospective study was conducted using data from the health surveillance programme (HSP) of the University Hospital of Verona (UHV) located in the Veneto Region (Italy).

Health surveillance programme

The HSP was established at a national level[12] to ascertain the SARS-CoV-2 virological status of all employees in healthcare settings, to protect the health of healthcare staff and their patients, and to ensure the continuity of care. Specific procedures aimed at implementing the HSP at the local level were developed by the Veneto region[13] as described below.

Setting and population. The HSP was conducted at the UHV, which is one of the main hospitals in the Veneto region, with 1215 beds and 124 day-hospital beds. As a high-level facility, it serves an area of 922,000 inhabitants, as well as patients from other Italian regions. The programme was organised and conducted by a specially appointed taskforce, comprising of staff from the Hospital Medical Management, Occupational Medicine and Microbiology Units, as well as residents of the postgraduate Schools of Hygiene and Occupational Medicine. The HSP included all UHV employees, staff temporarily operating at UHV structures (e.g. contractors, PhD students, internship holders) and University of Verona staff operating at UHV facilities. Employees on parental or sick leave and staff not currently working at the UHV were excluded from the HSP. All HCWs involved in the HSP between 29 February 2020, the date of the first swab collected in the UHV, and 18 May 2020, were included in this retrospective analysis.

HSP pathways for symptomatic and asymptomatic cases. The HSP had two different pathways for symptomatic and asymptomatic HCWs who had close contact with a SARS-CoV-2–infected individual (see Supplementary file). Close contact was defined as either contact with a SARS-CoV-2–infected individual within two metres, for more than 15 min and without any personal protective equipment, or an unprotected direct contact with the secretions of a SARS-CoV-2–infected individual. Asymptomatic close contacts were offered an oronasopharyngeal swab as soon as possible. Specific ambulatories were assigned to the HSP and the booking was managed by the staff of the task forces. HCWs who tested negative after close contact were exempt from quarantine, but they were monitored with swab repetition at days 7 and 14, starting from the date of close contact. For symptomatic (e.g. cough, rhino conjunctivitis, fever, ageusia, anosmia, sore throat) individuals who had come into close contact with a SARS-CoV-2 individual, a test was performed as quickly as possible in dedicated spaces of the emergency room to avoid contact with asymptomatic HCWs. If the test result was negative, they were required to stay home until resolution of symptoms and then to follow the HSP asymptomatic pathway.

If an individual had a positive test result to any of the swabs, home self-isolation was recommended for 14 days. At the end of this period, two swabs were performed, 24 h apart. Only if both swabs were negative the HCW was considered ‘recovered’ and allowed to go back to work. In cases where one of the two swabs tested positive, both swab tests had to be repeated after 7 days.

Prior to swab sample collection, a short epidemiological questionnaire was completed for every HCW (both symptomatic and asymptomatic), to ascertain the actual date of close contact, the presence of any symptoms, the nature of the contact (whether in the workplace or outside), and HCW age, working ward and personal contact details. Trained medical personnel, assisted by a professional nurse, collected oronasopharyngeal (both nostrils) swabs, in accordance with national and international guidelines.[14,15] Samples were tested for SARS-CoV-2 infection by a commercial real-time PCR method, Seegene AllplexTM2019-nCoV Assay (Seegene, Seoul, South Korea), which identifies the virus by a multiplex real-time PCR targeting three viral genes (E, RdRP and N gene). Samples were considered positive with a cycle threshold (Ct) value of $\leq$40 for at least one of the three target genes. Validation of the results was done with the National Reference Laboratory of National Health Institute.[16] Limit of detection of the AllplexTM2019-nCoV Assay was 4.8 copies/mL.

HSP screening. In addition to providing oronasopharyngeal swabs for individuals who were identified as having been in close contact with a SARS-CoV-2 patient, the HSP also provided testing to all HCWs, hence adopting a mass testing strategy.[17] Repeated screening swabs were carried out with different timings based on ward risk, in accordance with the protocols of the Veneto region.[13] Individuals working in high-risk wards were tested every 10 days, employees in the other clinical and surgical wards every 20 days, whereas the staff in the administrative sector were tested every 30 days. In the UHV, intensive care units, infectious and respiratory diseases wards and COVID units were considered as high-risk wards.

Ethics

In accordance with Decree-Law N.14 of 9 March 2020, personal data were collected to guarantee public health and to ensure the diagnosis and care of infected individuals in the context of the

COVID-19 emergency.[18] All the data were collected exclusively for the purpose of the HSP; they were anonymised and presented in an aggregated format to ensure privacy of the participants. The research was performed following the ethical standards of the 1964 Declaration of Helsinki and was launched and approved by the Institutional Board of the Veneto Regional Health Authority.[19]

Statistical analyses

A descriptive analysis was first conducted; frequency rates and percentages were used for categorical variables and medians for continuous variables. Cumulative incidence of COVID-19–positive HCWs was obtained through the Clopper Pearson method with an established 95% confidence interval (CI). Continuous variables were compared via the Mann-Whitney-U non-parametric test. Proportions for categorical variables were compared using the Chi-squared and Fisher's exact test. The median time to viral clearance (i.e. two consecutive negative tests, 24 h apart) was examined by Kaplan–Meier estimates. The association between clinical and demographic characteristics was investigated via Cox proportional hazard regression. Survival analysis was applied when considering either right- or interval-censored data.[20] With right-censoring analysis, the date of the second negative test was taken to be the exact recovery time. On the other hand, interval-censoring analysis considered the first positive swab as starting time point (t_0), the last positive swab before two consecutive negative swabs as left limit of the interval (t_l) and the second negative swab as right limit of the interval (t_r). A *P*-value <0.05 was considered significant. All analyses were performed using R software (version 3.5.2).

Results

Characterisation of COVID-19-positive HCWs

In the study period, 6455 HCWs underwent at least one oronasopharyngeal swab and 248 (3.8%; 95% CI: 3.4–4.3) tested positive for SARS-CoV-2 (Table 1). No significant differences emerged between the group of SARS-CoV-2–positive HCWs and non-infected HCWs with respect to age-, sex- or ward-related risk (Table 1). COVID-19-positive HCWs were identified either after referral to the HSP following close contact with a SARS-CoV-2–infected case (n = 217; 87.5%) or following the screening provided by the HSP (n = 31; 12.5%).

Of the 248 COVID-19-positive HCWs, 127 (51%) experienced at least mild symptoms (e.g. cough, rhino conjunctivitis, fever, ageusia, anosmia, sore throat). Symptomatic HCWs had a median age of 48.2 years and were significantly older than the asymptomatic HCWs (39.8 years, $P < 0.001$). Seven of the symptomatic subjects (5.5%) were identified through the screening provided by the HSP. For the 109 (85.8%) HCWs with a known date of symptom onset, the median time between this date and the first positive swab was 3 days (95% CI: 2–4). In 16 (14.7%) of the symptomatic HCWs, symptoms appeared after the first positive swab (with a median time-lag of 3.5 days).

During the study period, 95% (n = 236) of COVID-19-positive HCWs were back at work after two consecutive negative swab tests for SARS-CoV-2.

Recovery time estimation

The median time of recovery, starting from the first positive swab test result and taking the second negative swab as the last day of infection, was 24 days (95% CI: 23–26) (Fig. 1). At the end of the study, 156 (63%) HCWs needed more than 20 days to achieve two consecutive negative swabs. HCWs who were tested after having been in close contact with a SARS-CoV-2–infected case had a median recovery time of 25 days (95% CI: 23–28); however, the median recovery time was 21 days (95% CI: 16–24) for those who were tested as part of the HSP (Tables 2 and 3).

HCWs who required hospitalisation for SARS-CoV-2 infection showed statistically longer times for recovery than COVID-19-positive HCWs who were not hospitalised (33.5 days vs 24 days; $P = 0.005$) (Fig. 2).

The HSP scheduled tests at fixed time points. Data structure was therefore considered with an analysis for median recovery time in the presence of interval-censored data.[21] Results obtained with interval-censoring method showed a slight difference in the estimate of median time to recovery compared with right-censoring analysis. For interval-censoring data analysis, the median recovery time estimate was 21.5 days (95% CI: 15.5–30.5) (Fig. 1); having been in close contact with a SARS-CoV-2–infected case and hospitalisation were still found to be associated with a longer recovery time (Tables 2 and 3).

Discussion

To date, only a few studies have investigated the virological status of HCWs, even though SARS-CoV-2 is known to be a nosocomial agent[22] with important outbreaks occurring in hospitals and

Table 1
Healthcare workers characteristics distinguishing by swab, symptoms and hospitalisation.

Characteristic	Positive swab in HCWs			Symptoms in positive HCWs				Hospitalisation of positive HCWs		
	Yes (n = 248)	No (n = 6207)	p-Value[a]	Yes (n = 127)	No (n = 118)	Unknown (n = 3)	p-Value[b]	Yes (n = 12)	No (n = 236)	p-Value[b]
Sex [n (%)]			0.985				0.319			0.210
Male	80 (32%)	1906 (31%)		46 (36%)	33 (28%)	1 (33%)		6 (50%)	74 (31%)	
Female	168 (68%)	4301 (69%)		81 (64%)	85 (72%)	2 (67%)		6 (50%)	162 (69%)	
Age in years [Median (IQR)]	45.1 (31.1–53.9)	45.7 (32.3–54.1)	0.432	48.2 (33.8–54.9)	39.8 (29.9–52.3)	46.2[c]	<0.001	56.2 (45.3–60.9)	44.7 (30.9–53.2)	0.007
Ward [n (%)]			0.591							
High-risk[d]	24 (10%)	542 (9%)								
Low-risk	244 (90%)	5665 (91%)								

IQR, interquartile range.

[a] p-values were computed using Chi-squared test and Mann-Whitney-U non-parametric test.

[b] p-values were computed using Fisher's exact test and Mann-Whitney-U non-parametric test.

[c] IQR not reported because of the low number of subjects.

[d] Infectious disease and respiratory disease ward, intensive care unit, COVID unit.

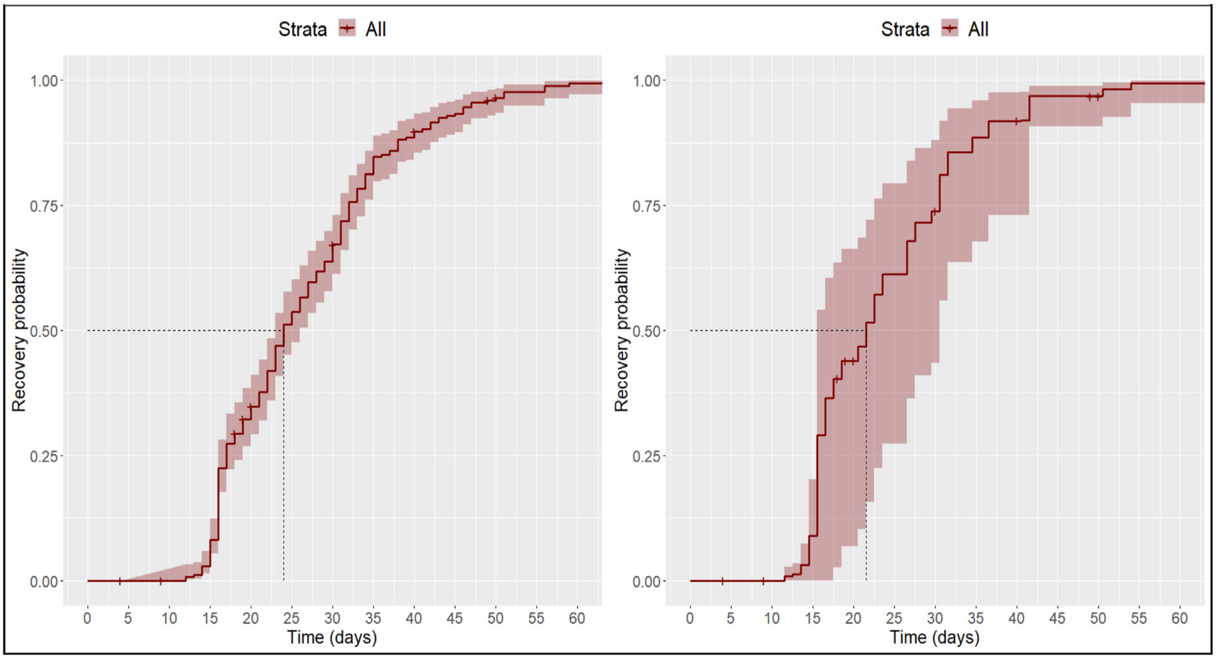

Fig. 1. Kaplan–Meier curves for recovery probability analysis with right-censoring data analysis (left panel) and interval-censoring data analysis (right panel). The left figure shows the Kaplan–Meier plot of time to COVID-19 recovery from the first positive swab to the last of the two negative swabs (performed with a time distance of 24 h) used to confirm viral clearance in healthcare workers. The right figure shows the Kaplan–Meier plot of COVID-19 recovery time in healthcare workers with interval-censoring data, considering the first positive swab as starting time point (t0), the last positive swab before two consecutive negative swabs as left limit of the interval (tl) and the second negative swab as right limit of the interval (tr). The median recovery time is the length of time corresponding to the probability of 0.5 (24 and 21.5 days, respectively, in the left and right figures).

in nursing homes.[23,24] Because asymptomatic individuals are thought to be contagious,[25–27] it is important to extend testing to all HCWs. Indeed, in the present study sample, almost half of the COVID-19-positive cases showed no symptoms at the time of testing. While no difference in age, sex or working ward was detected between negative and positive subjects, as shown in other studies,[24] the symptomatic cases were significantly older. Older people are known to be more severely affected by SARS-CoV-2.[28] A minority (14.7%) of the individuals who tested positive developed symptoms after the initial swab test. As infectiousness begins in the preclinical stage,[29] the HSP strategy was effective in identifying cases at disease onset, thus reducing the potential spread of the infection. HCWs who showed symptoms were not permitted to return to work and were rapidly tested.

In the study sample, 95% of COVID-19-positive HCWs had recovered at the time of data collection. The median time from the first positive swab to the second consecutive negative test was 24 days, which is similar to findings reported by Carmo et al.,[30] who found a median recovery time of 24 ± 9 days. Recovery times between 9.5[31] and 21 days[9,32,33] have been reported in other studies.[34,35] These differences may be due to different diagnostic strategies or to the timing of the first positive swab. Indeed, in our

Table 2
Kaplan–Meier estimation of recovery time considering right- and interval-censoring analysis.

Stratification variables	Right-censoring analysis			Interval-censoring analysis		
	n	Median recovery (days)	95% CI	n	Median recovery (days)	95% CI
Total	236	24.0	23–26	236	**21.5**	15.5–30.5
Sex						
Male	78	25.5	22–30	78	22.5	15.5–34.5
Female	158	24	23–26	158	20.5	15.5–30.5
Age group (years)						
25–29	32	20	17–23	32	16.5	15.5–31.5
30–39	61	25	23–31	61	23.5	15.5–39.5
40–49	42	27	22–30	42	22.5	17.5–31.5
50–59	81	23	20–26	81	20.5	15.5–30.5
60–66	20	29.5	23–24	20	25.5	21.5–30.5
Symptoms						
Yes	123	26	23–29	123	22.5	15.5–31.5
No	111	23	21–26	111	20.5	15.5–30.5
Close contact						
Yes	210	25	23–28	210	22.5	15.5–30.5
No	26	21	16–24	26	16.5	15.5–23.5
Hospitalisation						
No	224	24	22–26	224	21.5	15.5–30.5
Yes	12	33.5	27–56	12	29.5	26.5-NA[a]

CI, confidence interval.

[a] A 95% upper confidence limit of NA (infinity) is common in survival analysis due to the fact that the data is skewed.

Table 3
Recovery hazard ratios (HRs) estimated in the multivariate Cox proportional hazard model considering right- and interval-censoring analysis.

Characteristic	Right-censoring analysis			Interval-censoring analysis		
	HR	95% CI	*P*-Value	HR	95% CI	*P*-Value
Sex	0.93	0.70–1.23	$P = 0.614$	0.90	0.67–1.21	$P = 0.488$
Age	1.00	0.99–1.01	$P = 0.762$	1.00	0.99–1.01	$P = 0.780$
Symptoms	0.91	0.69–1.19	$P = 0.489$	0.95	0.69–1.30	$P = 0.766$
Close contact	0.44	0.28–0.69	$P < 0.001$[a]	0.48	0.32–0.71	$P < 0.001$[b]
Hospitalisation	0.42	0.23–0.77	$P = 0.005$[a]	0.46	0.22–0.96	$P = 0.039$[b]

CI, confidence interval.

[a] Recovery probability is 54% significantly lower in subjects who had a close contact compared to those who did not and 58% significantly lower in hospitalised subjects compared to non-hospitalised ones.

[b] Recovery probability is 52% significantly lower in subjects who had a close contact compared to those who did not and 54% significantly lower in hospitalised subjects compared to non-hospitalised ones.

study, there is a significant difference between those who were tested in the shortest time possible (i.e. because of being in close contact with an infected individual) and those who tested positive at the regular HSP testing. Individuals who tested positive as part of the HSP showed a shorter median recovery time (21 days), which is consistent with the aforementioned studies. Moreover, when we conducted a censoring-interval survival analysis to take into account the surveillance timing structure, the recovery time resulted in a median recovery time of 21.5 days, in line with literature data.[32,33]

Considering the two types of analysis (Fig. 1), recovery time estimated through a right-censored analysis describes the time needed to confirm (as per HSP criteria) the recovery of HCWs and thus to allow them back to work. This result plays a crucial role for the organisation and staff management. To adequately plan the level of safe staffing and to provide the continuity of care, a recovery time of at least 20 days should be considered. On the other hand, interval-censored analysis shows a better estimation of the time of viral clearance since it takes into account the interval between the last positive and the two negative swabs, when clearance is likely to have occurred.

In our study, the multivariate Cox proportional hazard model showed no significant differences in the time to recovery related to sex, which is consistent with the literature.[30,34,35] Age was also not related to a longer recovery time in our sample;[35] however, other studies, have found a significant association between older age and prolonged time to viral clearance.[34,36,37]

COVID-19-positive HCWs who required hospitalisation had a significantly longer recovery time, when all other covariates in the model were fixed. This result, confirmed in the censoring-interval analysis, highlights how the severity of the disease is an independent risk factor for a longer time of recovery and viral clearence.[34–36]

The main limitation of the present study is the retrospective study design. The analysis was based on data collected primarily for the HSP. Elderly people, who are most severely affected by COVID-19, are not represented in the HSP sample, which consisted of young and middle-aged HCWs. In addition, only a few HCWs in this investigation were hospitalised; thus, further studies are needed to confirm the associations suggested by the current results. These issues might limit the generalisability of the results, although the current findings have important implications for surveillance programmes and public health policies.

In Italy, the current guidelines,[11] based on the WHO strategy,[38] recommend testing after 10 days from the first positive swab in the case of asymptomatic individuals and testing after 10 days from the onset of symptoms (with at least 3 days without symptoms) in the case of symptomatic individuals. In accordance with the results of the present research, the time needed to achieve viral clearance is much longer and therefore such a close swab timing, while beneficial for a rapid re-integration into social life and into the workplace, might lead to repeated tests, thus becoming unnecessarily expensive. A longer time interval before testing to confirm

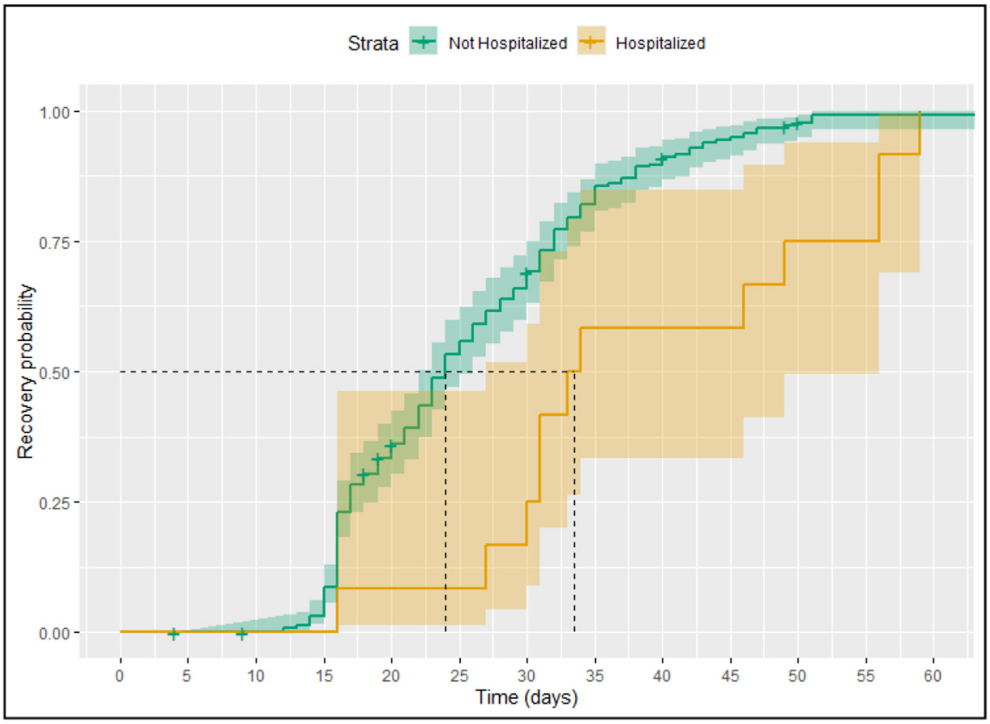

Fig. 2. Kaplan–Meier curves for recovery probability of hospitalised and non-hospitalised healthcare workers. The Kaplan–Meier plot was built without considering interval-censored data. Median recovery time was significantly different in the two groups of subjects (33.5 days in hospitalised and 24 days in non-hospitalised healthcare workers).

SARS-CoV-2 clearance in infected individuals might be advisable, especially in resource-limited countries.[30]

Conclusions

The viral clearance of SARS-CoV-2 and, consequently, the recovery assessment through a negative RT-PCR test takes a long time, especially in hospitalised individuals and in infected HCWs who had been in close contact with a SARS-CoV-2–infected case. This represents a serious burden for the health system and for personnel management. HCWs, hospital management and stakeholders should consider a recovery time of at least 20 days to optimise hospital resources.

A large proportion of infected individuals are asymptomatic at the time of testing[39,40] and it is known that infectiousness is already increasing from the preclinical and subclinical stage.[29] Therefore, it is important to test regardless of clinical presentation, especially in healthcare settings. Implementation of screening programmes in healthcare settings will allow testing of all personnel, including the HCWs, who may not report symptoms or may underestimate them.

Author statements

Ethical approval

The research was launched and approved by the Institutional Board of the Veneto Regional Health Authority.

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Competing interests

The authors declare that they have no conflicts of interest.

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Appendix A. Supplementary data

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Short Communication

Factors associated with reported likelihood to get vaccinated for COVID-19 in a nationally representative US survey

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ABSTRACT

Objectives: Although general principles related to vaccination hesitancy have been well researched, reports on reluctance to be vaccinated for coronavirus disease 2019 (COVID-19) in the United States are somewhat surprising, given the disease's substantive disruption of everyday life. However, the landscape in which people are making COVID-19 vaccination decisions has recently evolved with releases of encouraging vaccine-related data and changes to official messaging about the virus. Therefore, this study sought to identify factors associated with reported likelihood to get vaccinated for COVID-19 among US adults in late January 2021.

Study design: We used the Prolific online research panel to survey a nationally representative sample of 1017 US adults.

Methods: Respondents were asked about their behavioral intentions toward COVID-19 vaccination, trust in science, perceptions related to COVID-19, and selected sociodemographic factors. We computed associations between those 11 independent variables and likelihood to get vaccinated for COVID-19 using multiple linear regression.

Results: Around 73.9% of respondents indicated at least some likelihood to get vaccinated for COVID-19. Trust in science and perceived seriousness of COVID-19 were positively associated with intention to get vaccinated, and identifying as Black or African American was negatively associated with intention to get vaccinated. Other factors were moderately, weakly, or not at all associated with intention.

Conclusions: Building trust in science and truthfully emphasizing the seriousness of catching COVID-19 should be further researched for their potential to support campaigns to encourage COVID-19 vaccination. Data continue to suggest the importance of dialogue with Black communities about COVID-19 vaccination.

Introduction

Although much remains to be learned, early data on vaccines for severe acute respiratory syndrome coronavirus 2, the virus that causes coronavirus disease 2019 (COVID-19), are extremely promising,[1] and vaccines will likely play an important role in supporting a return to ‘normalcy’ in the United States (US). At the same time, reluctance to become vaccinated against COVID-19 in the US is surprisingly prevalent, including among current healthcare professionals[2] and those in training.[3]

Multiple robust studies of COVID-19 vaccination hesitancy were conducted early in the pandemic. A national US survey conducted in April 2020 identified several factors associated with COVID-19 vaccination hesitancy, including education, race, prior receipt of an influenza vaccination, and, from qualitative data, trust.[4] The latter finding is consistent with both a recent systematic review of

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the intersection of trust and vaccination more generally[5] and other studies about COVID-19 vaccination specifically.[6] Another large US study from May 2020 found associations between COVID-19 vaccination hesitancy and political orientation, perceived likelihood of infection, and perceived severity of infection.[7]

At the same time, and consistent with the review by Larson et al.,[5] vaccination studies have varied widely in who or what entity they ask about trusting (e.g. government, doctors, vaccines, or others). Furthermore, many such studies have used only a single-item measure of trust,[5] although Nadelson et al.[8] made a compelling case that trust is a complex construct with multiple interlinked layers. Our own research on COVID-19 misinformation,[9] which used Nadelson's conceptualization of trust in science and scientists, suggested the possibility that such trust, as measured using the 21-item scale of Nadelson et al.,[8] was associated with belief in misinformation about the disease. On that basis, we now postulate a potential association between trust in science and intention to get vaccinated for COVID-19.

Objective

As part of the effort to reduce the impact of COVID-19, it is critical to ensure that researchers and other experts have multiple robust sources identifying the factors associated with intention to get vaccinated for COVID-19. Thus, we conducted a nationally representative US survey of COVID-19 vaccination hesitancy, trust in science, and 10 theoretically selected covariates. Our approach specifically addresses two important issues with the field's current understanding: (a) recency: the COVID-19 vaccination landscape is in flux, so analyses with newer data are important, and (b) emphasis on nuanced trust: studies of vaccine hesitancy rarely use complex assessments of trust, and even fewer specifically examine trust in science (the 'origin' of the vaccine). Using a composite value for trust based on the work by Nadelson et al.[8] enables insight into how one might intervene on such a variable because at least 21 component parts are known, in contrast to a broader but more amorphous concept of 'addressing mistrust.'

Methods

A nationally representative US sample by gender, race, and age was recruited on January 22 to 24, 2021, using the Prolific online research panel service as part of a preregistered randomized trial[10] focused on COVID-19 misinformation.

Measures

For this study, a question measuring intention to get vaccinated for COVID-19 (from 1 [unlikely] to 7 [likely]) was added to the questionnaire after preregistration. Participants also provided information about their gender, race, ethnicity, and age, as well as responded to questions about whether they had been diagnosed with COVID-19, their trust in science (composite score from 1 [low] to 5 [high]), religious commitment (1 [low] to 10 [high]), political orientation (1 [liberal] to 10 [conservative]), perceived seriousness of contracting COVID-19 (1 [not at all] to 10 [very]), perceived ability to avoid COVID-19 in case of an outbreak (1 [not at all confident] to 5 [very confident]), and agreement that their family/friends avoided crowded areas (1 [strongly disagree] to 7 [strongly agree]) (see Supplement 1 for question wording and sources).

Analyses

Associations between those 11 independent variables and likelihood to get vaccinated for COVID-19 were computed using multiple linear regression via the generalized linear model. Normal distribution of the residuals was confirmed using the '/save resid' command. No problematic multicollinearity was observed. Categories with cell sizes <10 were collapsed for race, gender, and COVID-19 diagnosis. All analyses were conducted using SPSS version 26 (IBM).

Sample

A total of 1077 panel members accepted the survey. As prespecified in the protocol, the study incorporated checks to avoid inattentiveness, dishonesty, and virtual private network/bot use. Individuals who were screened out in this manner were replaced by individuals within the same race, gender, and age cross section. Twenty-three individuals were rejected and resampled for inattentiveness, likelihood of using a VPN or bot, or dishonesty. An additional two declined to participate after reading the study information sheets. Of the remaining 1052 members, 35 exited the survey without completing the required components and were resampled. Most often, those individuals reached a quality control question but did not finalize submission after being informed of being screened out. The remaining 1017 panel members included 1000 who were paid for their work and an additional 17 who fully completed the survey but did not submit a request to Prolific for compensation.

Of those 1017 participants, 49 (4.8%) reported having already received at least one shot of a COVID-19 vaccine (the national US vaccination estimate for January 22, the day most data were collected, was 5.3%; see source in Supplement 1). Because the dependent variable was likelihood to get vaccinated, those individuals were excluded. Missing data were rare (1.2% of all cases), so listwise deletion was used. The final sample was composed of 953 participants.

Results

Approximately 73.9% of respondents were at least somewhat likely to get vaccinated for COVID-19 ($\geq$5 of 7). The mean trust in science was 3.89 (standard deviation [SD] = 0.66), and each 1-point increase in trust in science was associated with a 1.03-point increase in likelihood to get vaccinated for COVID-19. Similarly, the mean perception of the seriousness of COVID-19 was 6.46 (SD = 2.67), and each 1-point increase in perceived seriousness of contracting COVID-19 was associated with a 0.21-point increase in vaccination likelihood. Respondents generally agreed that their family/friends avoided crowded areas (mean [m] = 5.62, SD = 1.47); each 1-point increase in agreement was associated with a 0.10-point increase in vaccination likelihood. Identifying as Black or African American was associated with a 1.08-point decrease in vaccination likelihood compared with those identifying as White. Finally, each 1-point movement toward 'conservative' was associated with a 0.13-point decrease in vaccination likelihood. Other associations were non-significant and generally weak; complete results are presented in Table 1, and descriptive statistics are available in Supplement 1.

Discussion

In a nationally representative US sample of adults, nearly three-quarters indicated they were at least somewhat likely to get vaccinated for COVID-19, mirroring recent national data from the Kaiser Family Foundation (see source in Supplement 1). Our data suggest two factors that might not be ideal vaccination intervention targets (i.e. those that were weak and non-significant): having a prior COVID-19 diagnosis and confidence in avoiding COVID-19 in case of an outbreak (e.g. perceived susceptibility). In addition, although family's/friends' avoidance of crowds was

Table 1
Parameter estimates.

Variable	β	SE	95% LL	95% UL	Wald χ^2	p
(Intercept)	0.790	0.609	−0.403	1.982	1.684	0.19
COVID-19 diagnosis from professionals						
Yes (reference)	–	–	–	–	–	–
No/unsure	−0.282	0.273	−0.818	0.254	1.066	0.30
Gender						
Male (reference)	–	–	–	–	–	–
Female	0.014	0.116	−0.213	0.241	0.015	0.90
Non-binary or transgender	0.193	0.294	−0.383	0.770	0.433	0.51
Race						
White (reference)	–	–	–	–	–	–
Black or African American	−1.078	0.205	−1.479	−0.676	27.708	<0.001
Asian	0.378	0.205	−0.024	0.781	3.403	0.07
Other	−0.267	0.347	−0.947	0.413	0.594	0.44
Hispanic or Latino/A						
Yes (reference)	–	–	–	–	–	–
No	−0.163	0.230	−0.614	0.288	0.503	0.48
Age	0.001	0.004	−0.006	0.009	0.103	0.75
Trust in science	1.026	0.106	0.818	1.234	93.173	<0.001
Religious commitment	0.006	0.020	−0.032	0.045	0.102	0.75
Political orientation	−0.134	0.292	−0.192	−0.077	21.195	<0.001
Seriousness of contracting COVID-19	0.207	0.025	0.159	0.255	71.338	<0.001
Confidence in avoiding COVID-19	−0.058	0.067	−0.188	0.073	0.752	0.39
Friends'/family's avoidance of crowded areas	0.103	0.045	0.014	0.191	5.137	0.02

COVID-19 = coronavirus disease 2019; LL = lower level; UL = upper level; SE = standard error.

significant, it contributed comparatively less explanatory power than other variables.

As reported in other studies,[4] Black or African American respondents reported lower likelihood than White respondents to get vaccinated for COVID-19. However, that finding should not be taken to mean that Black or African American communities uniformly resist COVID-19 vaccination. Rather, it is plausible that there are a number of unmeasured and interlinked factors that served to produce such a statistical association, such as concerns about access, the need for vaccinating authorities to foster community engagement, and authorities' need to foster, and be worthy of, institutional trust.

In addition, as expected,[7] perceived seriousness of contracting COVID-19 was markedly associated with vaccination likelihood, although, again, the same did not hold true for perceived susceptibility, highlighting an important distinction. Finally, trust in science was strongly and significantly associated with likelihood to get vaccinated for COVID-19. Although multiple types of trust are likely important for vaccination uptake (e.g. community trust in authorities, as discussed previously), this variable distinctly addresses trust in the broader scientific approach.

Limitations

Importantly, this was a cross-sectional exploratory study and was limited by non-random, online sampling and potential omitted variable bias. The findings were not causal. We specifically do not encourage any decisions to be made solely based on this study but suggest our findings might be incorporated into the evidence basis for COVID-19 vaccination hesitancy.

Conclusions

Interventions and public health campaigns should be driven by holistic review of all available evidence. Adding to that body of evidence, our work suggests several potential leverage points to boost vaccination (perceived seriousness and trust in science), reaffirms the need to meaningfully engage in vaccination dialog with Black communities, and identifies other factors that might plausibly be associated with vaccination uptake but that may not be effective intervention targets.

Author statements

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Ethical approval

This study was approved by the Indiana University IRB, #2008571490. All participants provided digital informed consent.

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Competing interests

J.A. owns a small amount (<1 share) of stock in Johnson & Johnson, which has produced a vaccine for COVID-19. No other financial relationships exist that are relevant to this manuscript.

Access to data

Data used for this study are part of an ongoing randomized trial and will be released in full alongside publication of that study. Data were provided to reviewers and editors during the review process.

Author contributions

J.A. conceptualized and designed this study. All researchers were involved in acquisition, analysis, and/or interpretation of data. J.A. drafted the first draft of the manuscript, and all authors revised the manuscript for important intellectual content. J.A., Y.X., and L.G.-A. conducted statistical analyses. J.A., Y.X., and E.E.T. obtained funding for the study.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2021.05.009.

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Original Research

Home participation, support and barriers among children with attention-deficit/hyperactivity disorder before and during the COVID-19 pandemic

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ABSTRACT

Objectives: Few studies have focused on the participation of children with attention-deficit/hyperactivity disorder (ADHD) in daily routine and leisure activities. This study aimed to compare the participation, support and barriers for children with ADHD at home pre-COVID-19 and during the COVID-19 outbreak.
Methods: The study included 55 children with ADHD aged 6–11 years. Participation frequency, involvement, desire for change, supports and barriers at home were assessed using the Participation and Environment Measure for Children and Youth (PEM-CY).
Results: During the COVID-19 pandemic compared with the pre-COVID-19 period, the mean frequency of participation of children with ADHD in computer and video games (5.8% vs 5%, respectively), socialising with other people (7% vs 6.2%) and household chores (5.5% vs 4.6%) was shown to be significantly higher ($p < 0.05$). Mothers of children with ADHD reported higher levels of involvement during the COVID-19 pandemic compared with the pre-COVID-19 period across four areas of home participation, including computer and video games (4.1% vs 3.2%, respectively), arts, crafts, music and hobbies (3.7% vs 3%), household chores (3.6% vs 2.8%) and personal care management (4.2% vs 3.5%) $p < 0.05$). Mothers of children with ADHD reported that during the pandemic the following two features of the environment made participation easier than pre-COVID-19 ($p < 0.05$): cognitive demands (36.4% vs 60%, respectively) and social demands (5.5% vs 34.5%). More mothers reported that services (92.7%), supplies (87.3%) and information (85.5%) were available and/or adequate in the COVID-19 period than pre-COVID-19 ($p < 0.05$).
Conclusions: Mothers of children with ADHD reported that their children were participating more frequently in some of the home-related activities during the COVID-19 pandemic compared to pre-COVID-19. Reduced cognitive and social demands, and more readily available resources in the home environment during the COVID-19 period resulted in increased home participation compared to pre-COVID-19.

Introduction

It is estimated that attention-deficit/hyperactivity disorder (ADHD) affects 5.3% of children worldwide.[1] ADHD is characterised by persistent symptoms of inattention and/or hyperactivity and impulsivity.[1] This common neurodevelopmental disorder results in many serious functional impairments in activities of daily living, including reduced academic performance, learning disabilities, motor disorders and negative impacts on interpersonal relationships, emotions and well-being.[2–4] Therefore, compared to their peers, children with ADHD have more functional difficulties in modulating sensorial feedback when participating in daily living activities.[2,5]

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Participating in activities of daily living is an essential part of human development and life experiences, and is necessary to achieve new abilities and skills.[6,7] Based on the International Classification of Functioning, Disability and Health (ICF) framework, participation is involvement in life situations among nine life areas, which include mobility, self-care, social interactions and life in different environmental settings.[8]

There is a growing recognition of the importance of participation for children with disabilities.[9,10] In addition to the symptoms of ADHD, social isolation and exclusion from interpersonal relationships can lead to social difficulties, and unexpected social changes might affect the participation of children with ADHD.[5] Few studies have focused on the participation of children with ADHD in daily routine and leisure activities.[2,5,7] The authors of these studies report that children with ADHD have lower daily function and participation intensity, and the preference for physical and social activities, activities requiring ability and formal activities is significantly lower than in typically developing children.[2,5,7] Moreover, children with ADHD have significant difficulties participating in daily activities at home, school and in community settings, especially in respect to self-care, home activities, spare time activities with their family and relationships with others.[11,12]

During the COVID-19 pandemic, children and adults all over the world have encountered serious difficulties. Governments declared lockdowns and schools were closed. Children with ADHD had to stay at home for at least 2 months; thus, losing their daily routines, school and community relationships and routine medical follow-ups. These factors created an increased risk of worsening of the ADHD symptoms.[13] Zhang et al.[13] reported that the behaviours of children with ADHD significantly worsened relative to the pre-COVID-19 period, especially noting worsening of anxiety, attention, routine and listening to information. As children with ADHD had to stay at home during the COVID-19 pandemic, it was considered important to investigate the in-home participation, supports and barriers. Thus, the in-home participation of children with ADHD was investigated during the COVID-19 pandemic compared to the pre-COVID-19 period. The secondary aim of the study was to describe the in-home supports and barriers to participation during the COVID-19 pandemic. To the best of our knowledge, no study has reported the in-home participation of children with ADHD during the COVID-19 pandemic compared to a pre-COVID-19 period.

Methods

Participants

The study included 55 children with ADHD, aged 6–11 years, and their mothers, who received services from the Child and Adolescent Psychiatry Clinic in Antalya, Turkey, between September 2019 and June 2020. The inclusion criteria of this study were: (1) being diagnosed with ADHD (inattentive, hyperactive-impulsive or combined type) by a child and adolescent psychiatrist based on the criteria of the Diagnostic and Statistical Manual of Mental Disorders (5th ed.):[1] and (2) being aged between 6 and 11 years. The study exclusion criteria were: (1) having a psychiatric condition, including psychotic symptoms, autism spectrum disorders and depression; (2) having an orthopaedic/neurological disorder, including head trauma, cerebral palsy, seizures, vision and speech impairment; and (3) parents not agreeing to participate in the study.

Measures

Participation and Environment Measure for Children and Youth

The Participation and Environment Measure for Children and Youth (PEM-CY) is a parent-report questionnaire used to assess participation and environmental factors in the home, school and community settings.[14] The participation section includes 10 items in home settings, five items in school settings and 10 items in community settings. For each activity, parents are asked to determine the participation frequency (i.e. how frequently has the child participated, with eight options ranging from daily to never), participation involvement (i.e. how involved the child is while participating in the activity, with a five-point scale ranging from very involved to minimally involved) and change desired (i.e. do the parents want to see a change in the participation of the child in this type of activity: yes or no). After answering the participation section, environmental features are evaluated to identify supports and barriers (i.e. do the features of the environment help or make it more difficult for the child to participate in activities in home/school/community setting). There are 12 items in the home setting, 17 items in the school setting and 16 items in the community setting. The PEM-CY has been shown to be valid and reliable for children.[9] According to a psychometric analysis study of the PEM-CY that included 178 children without disability and 210 children with a disability, the PEM-CY had moderate to very strong internal consistency and test–retest reliability (Cronbach's alpha = 0.67–0.93; intraclass correlation coefficients = 0.67–0.80).[9]

Sociodemographic questionnaire

Participants completed a questionnaire addressing family sociodemographic status, including family income, mother's education, child's age, gender, height, weight and medical history.

Procedure

Approval for the present study was obtained from the Local Ethics Committee of the university. Based on the principles stated in the Declaration of Helsinki, written informed consent was obtained from all participants. Mothers who agreed to participate in the study completed the PEM-CY and the sociodemographic form. The child and adolescent psychiatry department in Antalya, Turkey, is one of the reference centres of the city, and almost 100 families and their children present at the clinic every week. The majority of children attending the clinic have been diagnosed with ADHD. Before the COVID-19 pandemic, we routinely evaluated the children with ADHD using PEM-CY. The ‘pre-COVID-19’ evaluations were for the period between September 2019 and March 2020, as the first case of COVID-19 in Turkey was reported on 11 March 2020. We continued our routine evaluations until 20 March 2020, at which time the government declared a lockdown for the whole country and the children and their families had to stay at home for 2 months, from 4 April 2020 to 9 June 2020. During this period, the health of our patients was of great concern because they could not attend their routine follow-ups and we suspected some of them did not take their medicine. Therefore, between 2 and 5 June 2020, the mothers of children with ADHD were telephoned and asked about their child's health, retrospectively, and the PEM-CY was completed for the period defined as ‘COVID-19 pandemic’. A total of five participants could not be reached, two had changed telephone number and three did not answer. Finally, 55 children with ADHD and their mothers completed the PEM-CY after 2 months of lockdown.

Statistical analyses

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 23 for Macintosh (IBM SPSS Statistics; IBM Corporation, Armonk, NY, USA). The Shapiro–Wilk test, histograms and Q-Q-plot were used to evaluate the distribution of variables before test selection, and data were not normally distributed. To achieve 80% power to detect a difference with 95%

Table 1
Sociodemographic characteristics of participants ($n = 55$).

Characteristic	Mean (SD)	
Child age (y)	8.6 (1.6)	
Age at diagnosis (y)	8.1 (1.6)	
Child height (cm)	132.4 (11.05)	
Child weight (kg)	30.2 (7.8)	
Mother's age (y)	36.7 (6.4)	
	n	**%**
Child gender		
Male	47	85.5
Female	8	14.5
Drug use for ADHD		
Yes	27	49.1
No	28	50.9
Number of siblings		
0	8	14.5
1	29	52.7
2	14	25.5
3	3	5.5
4	1	1.8
Type of school		
Elementary	45	81.8
Secondary	10	18.2
Distance education during COVID-19 pandemic		
None	3	5.5
Internet	8	14.5
Television	44	80
Daily homework	24	43.6
Marital status, mother		
Married	42	76.4
Divorced	13	23.6
Level of education, mother		
Elementary school	14	25.5
Secondary school	12	21.8
High School	19	34.5
University/Graduate degree	10	18.2
Type of community		
Urban	41	74.5
Rural	14	25.5
Family Income (monthly)		
Below average	13	23.6
Average	24	43.7
Above average	18	32.7

ADHD, attention-deficit/hyperactivity disorder.

confidence using a paired *t*-test, a sample size of 47 participants was required, not including loss to follow-up. Analyses were performed to compare each home participation and home environment item for children with ADHD in the pre-COVID-19 and COVID-19 pandemic periods. The McNemar test was used to compare categorical responses, such as never participates, desire for change, environmental supports and barriers, between the two periods. The Wilcoxon test was used to compare the measurements at the two time points for frequency and involvement. A value of $p < 0.05$ was considered to be statistically significant.

Results

The sociodemographic characteristics of all participants are presented in Table 1. The mean age of children with ADHD was 8.6 years and they were predominantly male. Just less than half of the children (49.1%) with ADHD were taking medication. Most of the children (85.5%) had one or more siblings and were educated in elementary school (81.8%). Three children had no opportunity for distance education during the COVID-19 pandemic. More than half of the mothers (52.7%) were educated for more than 10 years. Many families lived in urban areas (74.5%) and had incomes in the ‘average’ to ‘high’ categories (76.4%).

Participation

For children with ADHD, the mean frequencies of participation and never participation for the 10 different home activity items during the pre-COVID-19 and COVID-19 pandemic periods are presented in Table 2. The mean frequency of participation in computer and video games, socialising with other people and household chores was statistically significantly higher during the COVID-19 pandemic compared to pre-COVID-19 ($p < 0.05$). The mean frequency of participation was significantly lower for socialising using technology and school preparation during the COVID-19 pandemic ($p < 0.05$). The percentage of children with ADHD who reported to never participate in the home activity of socialising using technology was consistently higher during the COVID-19 period.

Parents of children with ADHD reported higher levels of involvement in the COVID-19 period across the following four areas of home participation: computer and video games; arts, crafts, music and hobbies; household chores; and personal care management (Table 3). Lower levels of involvement than pre-COVID-19 were reported in the areas of socialising using technology and school preparation. During the COVID-19 pandemic, mothers reported less desire to change in their child's participation in the home-related activities of indoor play and games, socialising using technology, household chores and personal care management compared to the pre-COVID-19 period ($p < 0.05$). However, mothers more frequently indicated that they wanted some type of change in terms of school preparation during the COVID-19 period.

Environment

The support and resources available for the home environment of children with ADHD are shown in Tables 4 and 5. During the COVID-19 pandemic period, the mothers of children with ADHD less frequently reported that cognitive and social demands made participation more difficult than in the pre-COVID-19 period ($p < 0.05$). Fewer mothers of children with ADHD reported that the physical layout and physical demands of the environment were either ‘sometimes helps/sometimes makes harder’ during the COVID-19 period. However, during the same period, the majority of mothers of children with ADHD reported that sensory qualities and attitudes were either ‘sometimes helps/sometimes makes harder’. During the COVID-19 pandemic, mothers more often reported that physical layout, sensory qualities, physical demands, cognitive demands, social demands and relationship with family members were either ‘helpful or not an issue’. When asked whether certain resources in the home were sufficient and/or available to assist their child's participation, significantly more mothers of children with ADHD reported ‘usually, yes’ during the COVID-19 pandemic compared to pre-COVID-19 for services, supplies and information (Table 5).

Discussion

Many previous studies have focused on school activities and academic performance in children with ADHD and have shown ADHD to be associated with poor school performance.[15,16] However, children with ADHD aged 6–11 years spend a lot of their time at home. Based on ADHD symptoms, participation of children in activities in the home environment could be negatively impacted. A few studies have investigated the participation of children with ADHD in leisure activities, daily activity function and household tasks through comparisons with typically developing peers,[2,5,7,11] and it has been reported that children with ADHD participate less in leisure activities.[2,5] The COVID-19 pandemic is global and is

Table 2
Frequencies of home participation and never participation of children with ADHD between the pre-COVID-19 and COVID-19 pandemic periods.

Participation item	Participates				Never participates				
	Pre-COVID-19 [mean (SD)]	COVID-19 [mean (SD)]	z	*P*-value[a]	Pre-COVID-19		COVID-19		*P*-value[b]
					n	%	*n*	%	
Computer and video games	5 (2.8)	5.8 (2.35)	−2.16	0.03*	13	23.6	7	12.7	0.1
Indoor play and games	5.1 (2.3)	5.05 (2.74)	−0.16	0.86	7	12.7	11	20	0.38
Arts, crafts, music and hobbies	4.5 (2.7)	5.2 (2.34)	−1.73	0.08	13	23.6	7	12.7	0.18
Watching TV, videos and DVDs	6.5 (1.3)	6.2 (1.74)	−1.25	0.21	2	3.6	3	5.5	1.00
Getting together with other people	6.2 (1.3)	7 (0.01)	−3.78	<0.0001*	1	1.8	55	0	1.00
Socialising using technology	4.1 (3.1)	2.4 (3.14)	−2.79	0.005*	19	34.5	33	60	0.004*
Household chores	4.6 (2.4)	5.5 (2.42)	−2.87	0.004*	9	16.4	8	14.5	1.00
Personal care management	6.6 (0.8)	6.5 (1.6)	−0.95	0.34	55	100	3	5.5	0.25
School preparation (not homework)	5.1 (2.5)	1.5 (0.87)	−5.79	<0.0001*	9	16.4	4	7.3	0.26
Homework	5.8 (2.01)	5.8 (1.84)	−1.09	0.27	4	7.3	4	7.3	1.00

ADHD, attention-deficit/hyperactivity disorder.
*p < 0.05.
[a] Wilcoxon test.
[b] McNemar test.

Table 3
Involvement of home participation and change desired of children with ADHD between the pre-COVID-19 and COVID-19 pandemic periods.

Participation item	Involvement				Mother Desires Change				
	Pre-COVID-19 [mean (SD)]	COVID-19 [mean (SD)]	z	*P*-value[a]	Pre-COVID-19		COVID-19		*P*-value[b]
					n	%	*n*	%	
Computer and video games	3.2 (2.1)	4.1 (1.7)	−2.87	0.004*	39	70.9	36	65.5	0.6
Indoor play and games	3.4 (1.7)	3.3 (2.1)	−0.42	0.67	38	69.1	25	45.5	0.02*
Arts, crafts, music and hobbies	3 (2.01)	3.7 (1.8)	−2.42	0.01*	40	72.7	30	54.5	0.08
Watching TV, videos and DVDs	4.07 (1.3)	4.4 (1.3)	−1.41	0.15	43	78.2	33	60	0.07
Getting together with other people	3.8 (1.5)	4.2 (1.2)	−1.60	0.09	27	49.1	21	38.2	0.32
Socialising using technology	2.8 (2.2)	1.7 (2.2)	−2.44	0.01*	30	54.5	13	23.6	<0.0001*
Household chores	2.8 (1.7)	3.6 (1.8)	−2.66	0.008*	41	74.5	25	45.5	0.002*
Personal care management	3.5 (1.4)	4.2 (1.4)	−2.98	0.003*	34	61.8	15	27.3	<0.0001*
School preparation (not homework)	2.7 (1.8)	1.3 (0.8)	−4.7	<0.0001*	38	69.1	52	94.5	0.003*
Homework	2.6 (1.6)	2.9 (1.6)	−1.46	0.14	48	87.3	41	74.5	0.11

ADHD, attention-deficit/hyperactivity disorder.
*p < 0.05.
[a] Wilcoxon test.
[b] McNemar test.

Table 4
Perceived supportiveness of the home environment in children with ADHD between the pre-COVID-19 and COVID-19 pandemic.

Environmental item	Usually makes harder					Sometimes helps/sometimes makes harder					Usually helps/not an issue				
	Pre-COVID-19		COVID-19		*P*-value[a]	Pre-COVID-19		COVID-19		*P*-value[a]	Pre-COVID-19		COVID-19		*P*-value[a]
	n	%	*n*	%		*n*	%	*n*	%		*n*	%	*n*	%	
Physical layout	7	12.7	2	3.6	0.12	11	20	2	3.6	0.004*	37	67.3	51	92.7	<0.0001*
Sensory qualities	5	9.1	1	1.8	0.12	6	10.9	55	100	0.03*	44	80	54	98.2	0.002*
Physical demands	3	5.5	2	3.6	1.00	14	25.5	2	3.6	0.002*	38	69.1	51	92.7	0.004*
Cognitive demands	33	60	20	36.4	0.01*	12	21.8	11	20	1.00	10	18.2	24	43.6	0.01*
Social demands	19	34.5	3	5.5	0.0001*	9	16.4	12	21.8	0.66	27	49.1	40	72.7	0.01*
Relationship with family members	11	20	5	9.1	0.1	11	20	15	27.3	0.48	33	60	35	63.6	0.82
Attitudes	21	38.2	26	47.3	0.4	8	14.5	28	50.9	0.001*	26	47.3	1	1.8	<0.0001*

ADHD, attention-deficit/hyperactivity disorder.
*p < 0.05.
[a] McNemar test.

continuing with no known end in sight. A controlled social life with new rules has replaced the previous ‘normal life’ situation. Therefore, investigating the impact of the COVID-19 pandemic on the participation of children with ADHD is crucial. To the best of our knowledge, no study has investigated the participation of children with ADHD in home activities, and their supports and barriers in the home environment, both during the COVID-19 pandemic and the pre-COVID-19 period. The aim of this study was to investigate the home participation of children with ADHD, and their supports and barriers in the home environment, during the COVID-19 pandemic compared to the pre-COVID-19 period.

As a result of the COVID-19 pandemic, children with ADHD and their families have had to endure the difficult situation of school closures and lockdowns. The children had to stay at home for at least 2 months. Zhang et al.[13] reported that attention, anger frequency, listening to interactions and routines were significantly worsened in children with ADHD during the periods of lockdown in the COVID-19 pandemic. Results of the present study show an

Table 5
The resources of the home environment in children with ADHD between the pre-COVID-19 and the COVID-19 pandemic.

Resource item	Usually no					Sometimes yes/sometimes no					Usually yes				
	Pre-COVID-19		COVID-19		*P*-value[a]	Pre-COVID-19		COVID-19		*P*-value[a]	Pre-COVID-19		COVID-19		*P*-value[a]
	n	%	*n*	%		*n*	%	*n*	%		*n*	%	*n*	%	
Services	5	9.1	0	0	0.06	7	12.7	4	7.3	0.54	43	78.2	51	92.7	0.03*
Supplies	8	14.5	4	7.3	0.28	8	14.5	3	5.5	0.12	39	70.9	48	87.3	0.03*
Information	8	14.5	3	5.5	0.12	14	25.5	5	9.1	0.04*	33	60	47	85.5	0.001*
Time	8	14.5	5	9.1	0.5	17	30.9	14	25.5	0.64	30	54.5	36	65.5	0.26
Money	13	23.6	6	10.9	0.06	16	29.1	21	38.2	0.26	26	47.3	28	50.9	0.77

ADHD, attention-deficit/hyperactivity disorder.
*$p < 0.05$.
[a] McNemar test.

increase of 16% in the mean frequency of participation in computer and video games, 11.2% in socialising with other people and 20.6% in household chores during the COVID-19 pandemic. The possible reason for this is that children with ADHD had to stay at home, and they spent more time in the home using a computer and interacting with other family members. Also, many participants had one or more siblings and they spent lots of time with them. In parallel with this, there was a 41.1% decrease in the mean frequency of participation in socialising using technology during the COVID-19 pandemic. There was a 73.9% increase in the percentage of children with ADHD who reported to never participate in socialising using technology during the lockdown compared to pre-COVID-19. Children with ADHD were with their family members during the COVID-19 lockdown period, and therefore did not need to use mobile phones or other devices to communicate with each other.

Involvement is key in understanding the extent to which a child is able to or prefers to actively participate in activities.[17] In this way, involvement dimensions provide an opportunity to see different aspects of the child's participation.[17] The findings of this study demonstrate that there were greater differences in the involvement of activities than in frequency during the COVID-19 pandemic than the pre-COVID-19 period. Mothers of children with ADHD reported a 25.8% increase in involvement in computer and video games, a 25.3% increase in arts, crafts, music and hobbies, a 29.4% increase in household chores and a 20.5% increase in personal care management during the COVID-19 period.

In addition, the results showed that mothers wanted their children to spend less time on screens, both pre-COVID-19 and during the COVID-19 pandemic. More precisely, 70.9% of mothers reported that they wanted some type of change in their child's participation in computer and video games pre-COVID-19, and this rate was 65.5% during the COVID-19 lockdown. Mothers also less frequently reported that they wanted some type of change in their child's participation in four home-related activities; there was a 34.1% increase in satisfaction in activities of indoor play and games, 56.6% in socialising using technology, 38.9% in household chores and 55.8% in personal care management. These results suggest that the mothers were satisfied with the mean frequency of participation and the levels of involvement of their children with ADHD across the home activities during the COVID-19 pandemic, especially the decrease in the mean participation frequency in socialising using technology and the increase in the level of involvement in personal care management. However, almost all the mothers (94.5%) answered that they wanted to reopen the schools. The results of this study show that children with ADHD were more interactive with people or in household activities in the COVID-19 period. As the family were together for the duration of lockdown, children with ADHD had access to family members who could support them and respond to their cognitive and social demands in home activities. In addition, half of the mothers were educated to high school or university level, which could positively impact the cognitive and social demands of children with ADHD.

During the COVID-19 pandemic, support and resources of the home environment were improved relative to the pre-COVID-19 period for children with ADHD. Based on these findings, cognitive and social demands were more likely to hinder children with ADHD in the pre-COVID-19 period than during the pandemic. During the COVID-19 pandemic, the mothers of children with ADHD did not often select the ‘usually makes harder’ response when asked about the impact of cognitive demands of activities. The cognitive demands of activities were reported to be 39.3% less of a barrier in this study, compared to the findings of Zhang et al.[13] This might be because children and their families had spent quality time together, and this was reflected positively in the child's ADHD symptoms in the acute period of the COVID-19 pandemic. The other important factors that might act on the cognitive demands of children with ADHD were marital status of mothers, family income and living region (urban or rural). In the present study, most of the mothers were married, had an ‘average’ to ‘high’ income and were living in urban areas. In the pre-COVID-19 period, one of the biggest barriers for children with ADHD was reported to be the social demands of activities. Similar to these results, many studies in the literature have described the difficulties of children with ADHD in social areas.[7,18] However, the barrier of the social demands of activities were reduced by 83.8% during the COVID-19 period. The possible reason for this is that the children with ADHD spent more time with their siblings, parents and other family members during lockdown, and this reflected positively in their social and cognitive requirements in the acute period of the COVID-19 pandemic. However, the COVID-19 pandemic could be prolonged and could affect the social and cognitive demands of activities negatively in the long term. Future studies should investigate the long-term impact of the COVID-19 pandemic on children with ADHD.

Based on the results of this study, the resources in the home, including services, supplies and information, were sufficient and available to enable the participation of children with ADHD in activities during the COVID-19 lockdown. However, mothers of children with ADHD were more likely to report that the attitudes of teachers affected the participation of children with ADHD in online learning during the COVID-19 pandemic. These findings show that children with ADHD need access to a face-to-face education system.

A strength of this study was the investigation of the findings of home participation of children with ADHD as well as the supports and barriers of environmental features in the acute period of the COVID-19 pandemic through comparisons with the pre-COVID-19 period. Future studies should focus on school and community participation of children with ADHD during the COVID-19 pandemic by comparisons with typically developing peers. A limitation of this study was that there was a higher ratio of boys with ADHD.

The study findings suggest that children with ADHD need to spend more quality time with their parents and siblings in the home to increase participation frequency, involvement and to prevent barriers.

In conclusion, mothers of children with ADHD reported that their children were participating more in some of the home-related activities during the COVID-19 pandemic than in the pre-COVID-19 period. The features of cognitive and social demands and the resources of the home environment did not constitute barriers to home participation during the COVID-19 pandemic as much as in the pre-COVID-19 period.

Author statements

Ethical approval

This study was approved by the Ethics Committee of Health Sciences University (2020-271).

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Competing interests

The authors have no conflict of interests to declare.

Author contributions

Ozgun Kaya Kara: writing - original draft preparation, conceptualisation, methodology; Hasan Atacan Tonak: visualisation, investigation; Koray Kara: supervision, reviewing and editing; Hazal Sonbahar Ulu: data curation, software; Barkin Kose: visualisation, investigation; Sedef Sahin: supervision, reviewing and editing; Mahmut Zabit Kara: supervision, reviewing and editing.

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Short Communication

Interpretive voices: coproducing creative enquiry in the time of COVID-19

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ABSTRACT

Objectives: The objective of the study is the development of a virtual pilot of student and clinician creative enquiry during the COVID-19 pandemic lockdown.
Methods: Evaluation of the pilot was carried out by a student-staff team and included review of creative pieces submitted, their impact and team reflection, drawing on the differing perspectives of staff and students.
Results: A series of powerful creative enquiry texts have been published and presented from this pilot. Evaluation suggests individual and group flourishing are possible through creative expression and dialogue. Coproduction allows development of innovative and complex virtual educational spaces.
Conclusion: Creative enquiry enables working across hierarchies, disciplines, and the virtual realm to build connection, relationship, and solidarity. Work is needed to create psychological safety and to support wider student engagement.

Objectives

COVID-19 has been a time of great loss and challenge. The cancellation of clinical placements, alongside student involvement in the frontline COVID-19 response, may have served to compound the burnout already documented amongst medical students.[1,2] Medical student well-being was under investigation even before the pandemic,[3] but evidence as to what works has been lacking.[4] Engagement with the arts has the potential to address burnout and promote well-being but remains largely unexplored in medical education despite growing evidence of benefit in our patient populations.[5]

In response to the pressures of the pandemic a team of students and clinicians (psychiatrists, G.P.) numbering up to a maximum of eight people in a session, established a lockdown *creative enquiry* pilot called ‘Interpretive Voices’. Creative enquiry is the reflective exploration of lived experience through the languages of the arts e.g. writing poetry, sculpture, photography, painting, and so on. This pilot's aims were threefold. First, students would be enabled to produce creative enquiry texts exploring their experience of the pandemic. Second, the pilot would evaluate the impact of creating these texts on students' sense of connection and well-being. Third, the pilot's structure would be innovative, evidencing student leadership and coproductive working to develop complex virtual educational spaces.

The concept of the pilot built on previous *face-to-face* creative enquiry education with students.[6] The approach was adapted for the virtual environment through coproductive engagement between clinician educator and students. A core group of students-staff met to develop the pilot (5 students, 1 clinician educator). Themes were collectively chosen by participants: examples included ‘hands’, ‘the metaphor of medicine as war’, ‘solitude and the encounter’. The theme lead (student or clinician) created a provocation, inviting responses through any of the arts – music, film, animation, dance, painting and poetry – accompanied by written reflection. We used our website to promote the theme, as well as Twitter and Instagram (@CreativeEnquiry).

Monthly Zoom meetings allowed group discussion of the submissions. Different facilitators adopted a variation on approaches, but broadly sessions started with a short creative enquiry exercise to invite ‘flow’ involving shared silence, concentration, and presence. These simple exercises allowed easy engagement with a focus on process rather than outcome: for example, a simple doodling exercise. The starter exercise was then followed by screen-sharing and dialogue around the submitted creative texts, exploring one at a time.

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Methods

All core team members were invited to engage in this evaluation. Two students and a clinician carried it out (to ensure differing perspectives invited) with support from the team (giving written feedback, member checking this paper). We reviewed the images submitted, choosing one which was particularly pertinent to share as an example in this article. We collated the places where the creative enquiry work was shared and reviewed any available feedback responses from wider public engagement. Further feedback from anyone involved in the pilot was gathered with an anonymous google form and collated by the student authors.

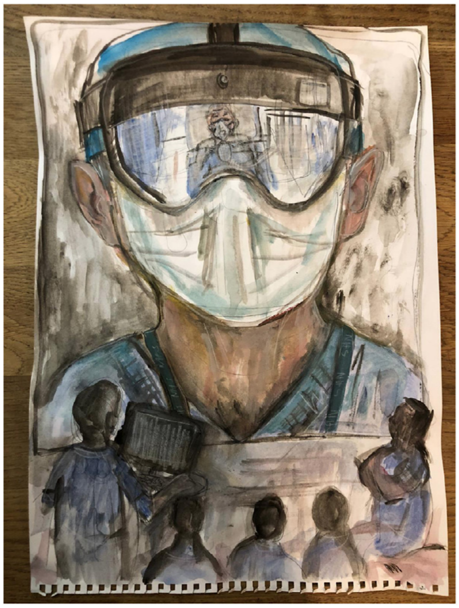
Results

1) Creative enquiry texts

A series of powerful *creative enquiry texts* (26 in total) that speak across four themes into this time of COVID were produced and shared. These creations and their accompanying reflections have been published,[7] presented at multiple conferences,[8] symposia and faculty development events and shared via social media. For example, at a flourishing and creative enquiry symposium this ‘Plastic bag’ gif was shared. People responded with:

> *… this means a lot to me …- I was a relative needing to get food to be given to my father in hospital. love your work- thanks*

The following example is from the theme, ‘Solitude and the encounter’, poignantly relating to experiences during lockdown where many social interactions and all medical student teaching was via online platforms.



Virtual Reality - by Freya Elliott.

Reflection

> *… In the reflection on the doctor's goggles you can see the patient they are treating being ventilated in their hospital bed. The shadowy figures at the bottom of the screen represent a group of healthcare professionals seeing the patient via cameras on the doctor's goggles …*

This is one of the images shared at the monthly zoom meeting. Seeing this image, students who had volunteered in hospital during the peak of the pandemic shared their experiences: one student reflected that wearing PPE meant their patients ‘cannot even see me smile’. Other students were struck by the vulnerability and separation of the patient in the image juxtaposed with the facelessness of the main figure, concealing their humanity. Themes around the humanity and lived experiences of doctors, students and patients were shared and talked about.

2) Group flourishing, connection and learning

Group written survey feedback collected by an anonymous google form suggested that the pilot did enable student flourishing, connection and learning during a very difficult time. COVID-19 threw up questions about professional responsibility and personal safety for students and clinicians. By creating and discussing art, students were able to work through some of the challenges:

> *‘The zoom meetings provided space to talk about whatever we were going through in lockdown by using pieces we'd created. I was surprised by how honest we all felt we could be and how personal a lot of the art was.’*

One recurrent theme in participant feedback was the depth and joy of sharing through the creative enquiry process. Learning through the virtual realm has been described as isolating for students.[1] In contrast, virtual creative participation in group sessions facilitated connection and was described as a personal resource:

> *‘I was definitely surprised by how much I loved the group element of it! I did not expect to enjoy the meetings so much and in fact it was these meetings that were a huge factor in getting me through the lockdown period…’*

The connection and sharing made possible in these sessions stands in contrast to the hidden curriculum and competitive culture of medical education:

> *‘The creative enquiry projects acted as a really good vehicle for some much needed reflective conversation which I had always wished I could have with other students yet would fear bringing up myself often!’*

The group learned with and from each other as creative texts were explored and horizons expanded:

> *‘Being able to see how people articulated their thoughts and experiences helped me to examine and understand my own.’*

Learning also took place in terms of students being empowered to lead sessions, engaging in the art of facilitating creative enquiry groups:

> *‘Being given the opportunity to run a theme and zoom meeting was a highlight.’*

3) Coproduction of innovative and complex virtual educational spaces

Creating a learning-sharing space virtually in medical education where students are engaging in creative forms of expression, potentially making themselves vulnerable is challenging. Although L.Y. has a long history of facilitating creative enquiry face-to-face, the virtual landscape is different.

Reducing hierarchies and working coproductively to innovate a new learning space where students also led and facilitated the group was essential for the building of trust even during the sometimes messy process of managing the technical-emotional dimensions of this work. All facilitators (students or clinicians) aimed for psychological safety[9] in the group, drawing on concepts such as vulnerable leadership,[10] setting ground rules and inviting participants to attend to their own boundaries, sharing only what they were comfortable with.

Conclusions

This creative enquiry pilot facilitated a supportive and exploratory space, shared at a time of great uncertainty for both students and clinicians. It was underpinned by an ethos of collaborative leadership, fostering psychological safety, as well as creative engagement and dialog. Innovations were multiple and included the voluntary nature of the group, the coproductive design coupled with collaborative leadership across staff and students, as well as the use of virtual space (zoom) and the student-staff shared twitter account for wider sharing (@CreativeEnquiry).

One limitation of the pilot included limited participation outside of our core group. Students commented on the positive side of this, being able to be open and honest, but also noted that it ‘would have been nice to see more students engaging’. This should be explored further in future, but may be due to the voluntary nature of this group, as well as issues of safety in attending a new virtual group, especially when linked to creative enquiry which may be conflated with a baseline level of artistic skill or involving the potential for exposure of the self.

This pilot work demonstrates the feasibility of virtual creative enquiry in medical education with interested students. Working across hierarchies, disciplines, and the virtual realm, we found it possible to build connection, relationship, and solidarity through the arts, supporting individual and group flourishing. The question remains at this time of great grief and trauma, how might we better connect in meaningful ways with a broader group of future students and doctors?

@CreativeEnquiry
website www.creativeenquiry.qmul.ac.uk

Author statements

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Competing interests

None declared.

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Review Paper

The efficacy of vaccination to prevent human papilloma viruses infection at anal and oral: a systematic review and meta-analysis

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ABSTRACT

Objective: The objective of this study was to review evidence on the effectiveness of vaccination in the prevention of human papilloma virus (HPV) infection at the cervix, anal, and oral.
Study design: Systematic review and meta-analysis.
Methods: The key search limitations are as follows: “Human Papilloma Virus”, “Papilloma Virus, Human” “Human Papillomavirus Virus”, “HPV” and “oral”, “anus”, “anal”, “penis”, “cervical,” and “vaccine”. Randomized controlled studies were searched and analyzed the risk ratio by Review Manager 5.3; funnel plot was adopted for publication bias analysis.
Results: Five randomized controlled studies enrolling 13,686 participants were retrieved, analyzed, and showed that HPV vaccination can effectively block HPV infection at cervical, anal, and oral. Subgroup analysis, moreover, proved that HPV 16/18 is more effective than HPV 6/11/16/18 in preventing anal and oral infections.
Conclusion: HPV vaccine is efficacious in preventing HPV infection not only at cervical but also at anal and oral, as evidence supported by relevant studies.

Human papilloma virus (HPV) has been proved as a double-stranded DNA virus and it has the characteristics of predilection for squamous epithelium.[1–3] Although more than 200 HPV types were isolated, people have already noticed that the high risk HPV types are inextricably linked with cervical cancers.[4,5] HPV persistence will induce malignant transformation,[2,6] and after infections, HPV will transcribe viral proteins to tamper or damage those tumor suppression genes.[7,8] Women are traditionally susceptible to HPV infection, but fortunately, most of infections can be cleared by autologous autoimmunization in one or two years.[2,3] Yet the oncogenic capacity of HPV can cause mental stress doubtedly, and the treatment for cancers must be painful and expensive obviously. So, HPV infection on female has generated enormous publicity and the HPV vaccines, since the first vaccine Cervarix® or Gardasil®, have gained substantial acceptance even in developing countries.[9–11]

On the other hand, the analogous mucosal tissue is wildly existed in oral cavity or anus.[12] Exfoliative cell examination for HPV is rare used in oral cavity or anus, so there is broad concern because HPV would not likely be the archcriminal only for cervical cancer, but also for anal cancers and oral cancers,[5,12–19] especially related to double sexuality, that is male homosexuality or to the people with peculiar sexual intercourse.[20–22] Therefore, we must actively prevent HPV infection at oral cavity and anus.[1,18,19,22,23]

Vaccines themselves cannot eradicate or inhibit viruses; the effectiveness of HPV vaccination to the previously exposed or infected people may not be remarkable. However, it should be emphasized that vaccination has the ability to prevent reinfection;[24,25] in other words, lower reinfection probability means less possibility of disruption on tumor suppression genes.[8] Vaccination can arouse immune response systemically and it is not confined in human cervix.[26] It is hypothesized that the antigen-specific adaptive immune response activated by HPV vaccine can prevent HPV infection at cervix, but its adaptive immune response also provides a degree of protection to those susceptible sites against the HPV infection. In other words, HPV vaccine can improve the prevention of infection at cervix and also oral and anal.[27,28]

Newly published reviews analyzed the uncertainties of the benefits and harms of the HPV vaccines[29] or summarized single-

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dose HPV vaccination may be as effective in preventing HPV infection as multidose schedules in healthy young women.[30] However, it is not clear that the efficacy of vaccination to prevent human papilloma viruses infection at cervix, anal, and oral. The effectiveness of HPV transmission in different sites should be more emphasized. To justify the hypothesis, it has been analyzed several randomized controlled studies about the protective effect of HPV vaccines at anal and oral.[27,28,31–33] The pooled results shown that HPV vaccine is efficient to prevent HPV infections at cervix and also at anal and oral. This conclusion can be used as a basis for that HPV vaccination is a positive prevention to HPV infections and cancerization at anal and oral, especially to male, who have less opportunity and less recognition to receive HPV vaccine.[4,34–37]

The aim of this review was to address the uncertainties of the effectiveness of vaccination in the prevention of HPV infection at the cervix, anal, and oral. A systematic review with meta-analysis of trial data from clinical study reports was conducted.

Methods

Literature criteria on inclusion and exclusion

Inclusion criteria were followed basic standard as: the study type is confined to a randomized controlled study; the language is limited to English.[38]

Exclusion criteria: repeated publication; research without full text, incomplete information or inability to conduct data extraction; cohort or case–control studies; case series; editorials; case reports; articles with sample sizes less than five; animal experiments; reviews, and systematic reviews.

Search strategy

In this meta-analysis, three broadly recognized databases were searched, PubMed, Embase, and Cochrane Library, from the establishment of the database to October 2020. The Mesh terms are as follows:[39] “Human Papilloma Virus”, “Papilloma Virus, Human” “Human Papillomavirus Virus”, “HPV” and “oral”, “anus”, “anal”, “penis”, “cervical” and “vaccine”.[38] The combinations search strategies were as follows:[39] “HPV” and “oral”/“anus”/“anal”; “Human Papilloma Virus”/“Papilloma Virus, Human” and “oral”/“anus”/ “anal”; “cervical” and “oral”/“anus”/“anal”/, “vaccine” and “oral”/ “anus”/“anal”; “cervical”, and “vaccine”.[38]

Literature screening and data extraction

All the outcomes were independently got by two researchers. The literature search, screening, and data extraction were all independently completed by two researchers procedurally. When there were doubts or disagreements, the decision was made after

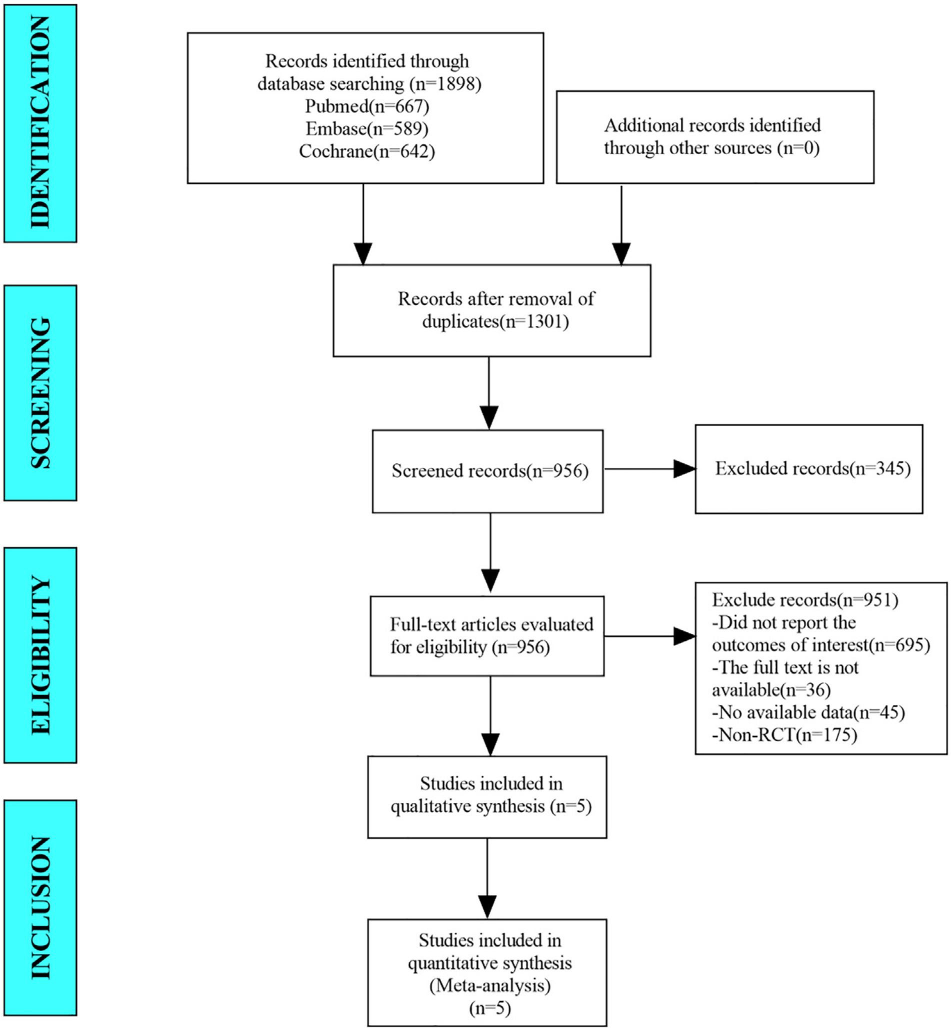
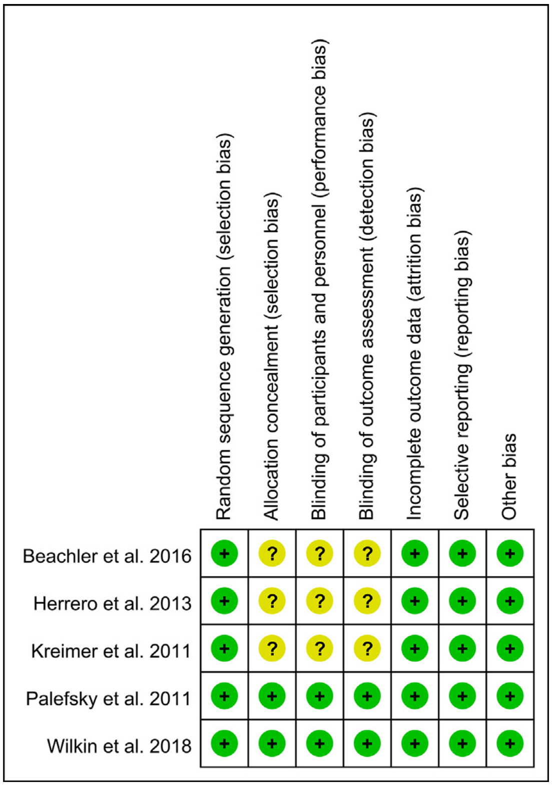


Fig. 1. Flow diagram for selection of studies.



	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Beachler et al. 2016	+	?	?	?	+	+	+
Herrero et al. 2013	+	?	?	?	+	+	+
Kreimer et al. 2011	+	?	?	?	+	+	+
Palefsky et al. 2011	+	+	+	+	+	+	+
Wilkin et al. 2018	+	+	+	+	+	+	+

Fig. 2. Quality assessment of the included studies.

discussing or consulting with a third party. The data extraction included the author, year, region, research type, number of cases, and outcome indicators[40] (Fig. 1).

Literature quality assessment

Two researchers independently carried out the quality evaluation of the mentioned literatures, using the Review Manager 5.3 software risk assessment tool, based on the Cochrane risk assessment scale. In accordance with the random sequence generation, allocation hiding, blinding, whether the research results are blindly evaluated, and the result data are completely evaluated from the included literatures based on gender, choice of research results, other biases, etc., and decided after discussion and consultation with a third party when opinions on results are inconsistent. This meta-analysis is performed based on the related items of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis statement[41] (Fig. 1).

Data synthesis and statistical analysis

Data were analyzed by Review Manager 5.3. risk ratio (RR) (95% confidence interval [CI]) was used as the binary variable. If the heterogeneity test results $P \geq 0.1$ and $I^2 \leq 50\%$, it means that there is of homogeneity between studies, while the fixed effects model is applied to combined analysis; if $P<0.1$, $I^2>50\%$, it shows that if the study is of heterogeneity, sensitivity analysis or subgroup analysis should be applied to explore the source of heterogeneity. If heterogeneity is still significant, use the random effects model or give up the combination of results and use descriptive analysis.[36] Funnel plot was used to analyze publication bias.

Results

The results of literature search

In this study, a total of 1898 studies were retrieved from the database. After eliminating duplicate studies, 1301 were obtained. After browsing titles and abstracts, 956 studies were obtained. We excluded a lot of literature for the following reasons: Did not report the outcomes of interests; no available data, and non-randomised controlled trial. Finally, five studies were finally meta-analyzed through full-text reading.[27,28,31–33]

Baseline characteristics and quality assessment of the subject studies

Baseline characteristics

The baseline characteristics and quality assessments of the subject studies are shown in Table 1.

Quality assessment of the subject studies

Quality assessment showed that there are two articles with a score of 7 and the remaining articles are also with a score of 4 or more. The quality of the articles included in this study is acceptable (Fig. 2).

Results of meta-analysis

Analysis showed that the incidence of anal (RR = 0.42, 95% CI: 0.31–0.57; $I^2 = 65\%$, $P = 0.02$), oral (RR = 0.16, 95%CI: 0.03–0.78; $I^2 = 56\%$, $P = 0.10$), and cervical infections (RR = 0.22, 95%CI: 0.15–0.32; $I^2 = 63\%$, $P = 0.07$) was in great extent lower than that of the control group after HPV vaccine was planted, indicating that HPV vaccination can improve the prevention of HPV infection not only at the cervix[9] but also at oral or anal. HPV vaccination could be an effective preventive measure against oral carcinoma and anal carcinoma caused by HPV.[1,16,42] (See Fig. 3).

Subgroup analysis

To further understand the difference in prevention efficiency between different vaccines, we further conducted a subgroup analysis. The pooled results deservedly found that HPV 16/18 is more effective than HPV 6/11/16/18 in preventing anal infections (0.34, 95% CI: 0.22–0.52; 0.53, 95% CI: 0.36–0.79). Similarly, this

Table 1
Baseline characteristics.

Author	Year	Region	Research Type	Number of cases		Gender (male/female)		Age		HPV types
				HPV group	Control group	HPV group	Control group	HPV group	Control group	
Wilkin[33]	2018	USA	RCT	288	287	236/52	236/51	47 (40, 52)	48 (42, 53)	6/11/16/18
Beachler[27]	2016	USA	RCT	2094	2092	0/2094	0/2092	18–25		16/18
Palefsky$_1$[28]	2011	Europe and America	RCT	275	276	275/0	276/0	16–26		6/11/16/18
Palefsky$_2$[28]	2011	Europe and America	RCT	275	276	275/0	276/0	16–26		16/18
Kreimer[31]	2011	Europe and America	RCT	1003	986	0/1003	0/986	/		16/18
Herrero[32]	2013	Europe and America	RCT	2910	2924	2910/0	2924/0	/		16/18

HPV, human papilloma virus; RCT, randomised controlled trial.

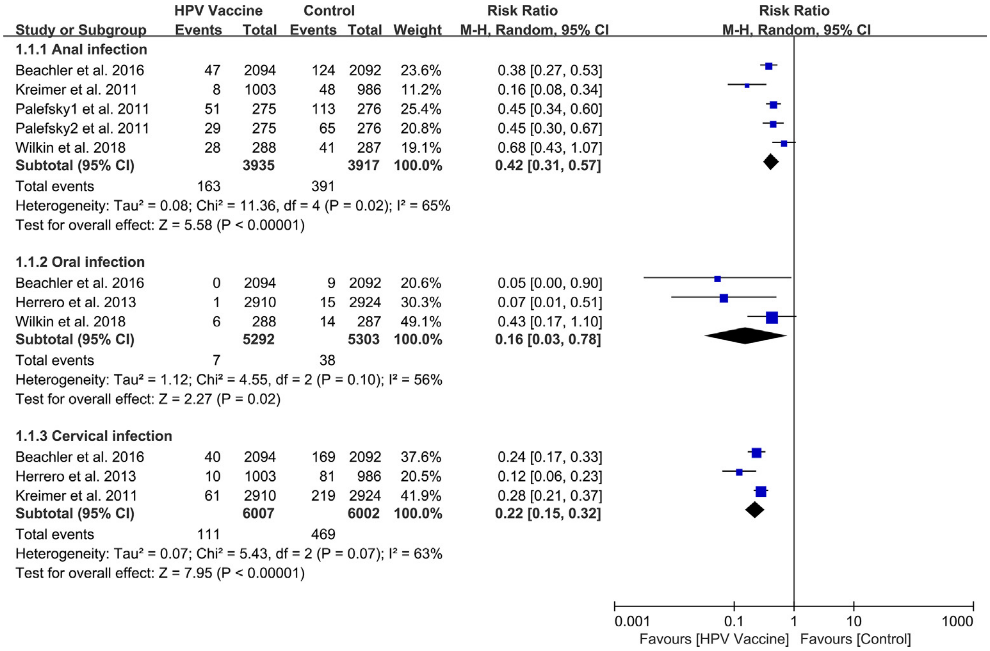


Fig. 3. The effectiveness of HPV vaccines in preventing anal, oral, and cervical infection. CI, confidence interval; HPV, human papilloma virus.

result was also found in the analysis of oral infections (0.06, 95% CI: 0.01–0.32; 0.43, 95% CI: 0.17–1.10) (See Figs. 4 and 5).

Publication bias

The funnel plot of this study is shown in Fig. 6. It can be seen that the funnel plot is basically symmetrical, implying no obvious publication bias in the results of this study.[38,43,44]

Sensitivity analysis

Sensitivity analysis eliminates each included study one-by-one, and performs a summary analysis on the remaining studies to assess whether a single included study has an excessive impact on the entire meta-analysis results. None of the studies had an excessive impact on the meta-analysis results, indicating that the results of the remaining studies are stable and reliable.

Discussion

Any clinical conclusion cannot be made before the analysis of enough clinical data, this is essential requirement of evidence-based medicine, and meta-analysis is wildly used in this field. The meta-analysis can combine the research data from different studies to shun deviation caused by a small sample size.[38] In addition, meta-analysis can research into more relevant factor by subgroup analysis or heterogeneity examination. So it is believed that the meta-analysis is an objective method to verify clinical hypothesis. Based on this reason, it is hoped to explore the preventive effect of HPV vaccines not only at the cervix, but also at anal and oral.

HPV is the important risk factors of cervical cancer and it is also the etiological factor for epithelial malignancies including anal cancers and oral cancers,[1,14,19,22,45,46] the conclusion of this study speculates that the HPV vaccine will provide protective effect to avoid HPV infection at the anus or oral, as the compellent

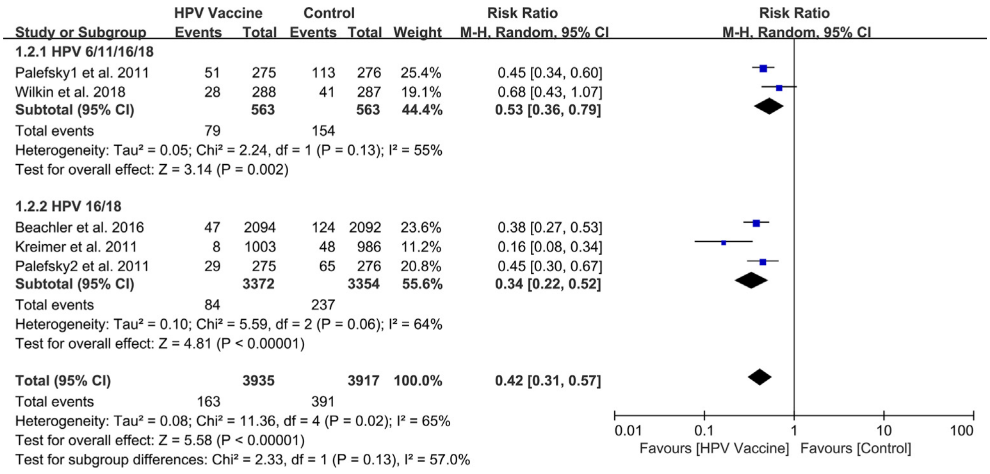
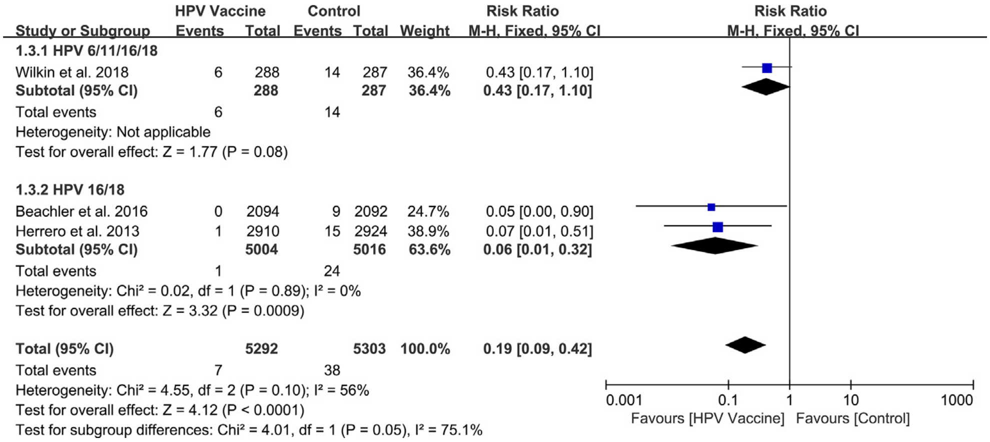


Fig. 4. The effectiveness of different HPV vaccines in preventing anal infection. CI, confidence interval; HPV, human papilloma virus.



Study or Subgroup	HPV Vaccine Events	HPV Vaccine Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
1.3.1 HPV 6/11/16/18						
Wilkin et al. 2018	6	288	14	287	36.4%	0.43 [0.17, 1.10]
Subtotal (95% CI)		**288**		**287**	**36.4%**	**0.43 [0.17, 1.10]**
Total events	6		14			
Heterogeneity: Not applicable						
Test for overall effect: Z = 1.77 (P = 0.08)						
1.3.2 HPV 16/18						
Beachler et al. 2016	0	2094	9	2092	24.7%	0.05 [0.00, 0.90]
Herrero et al. 2013	1	2910	15	2924	38.9%	0.07 [0.01, 0.51]
Subtotal (95% CI)		**5004**		**5016**	**63.6%**	**0.06 [0.01, 0.32]**
Total events	1		24			
Heterogeneity: Chi² = 0.02, df = 1 (P = 0.89); I² = 0%						
Test for overall effect: Z = 3.32 (P = 0.0009)						
Total (95% CI)		**5292**		**5303**	**100.0%**	**0.19 [0.09, 0.42]**
Total events	7		38			
Heterogeneity: Chi² = 4.55, df = 2 (P = 0.10); I² = 56%						
Test for overall effect: Z = 4.12 (P < 0.0001)						
Test for subgroup differences: Chi² = 4.01, df = 1 (P = 0.05), I² = 75.1%						

Fig. 5. The effectiveness of different HPV vaccines in preventing oral infection. CI, confidence interval; HPV, human papilloma virus.

effectiveness in the cervix uteri.[27,47] If so, HPV vaccination will stand a good chance for prevention malignant tumors developing from the epithelial cells not only in the cervix uteri. In this research, acceptable five studies were screened out for meta-analysis,[27,28,31–33] and the result showed that the incidence of HPV infection is dramatic declined at anal and oral after the HPV vaccination, it is consistent with the vaccine efficacy against HPV infections at cervical regions. This result is matching with formerly research about multivalent vaccine efficacy against cervical, anal, and oral HPV infection.[27] So HPV vaccination could be an effective preventive measure to withstand the HPV-associated cancers,[12,48,49] such as oral carcinoma[18,23] or anal carcinoma.[19,50]

Also be aware that by default, based on the subgroup analysis, it was found that the bivalent vaccine (16/18) is more effective than the tetravalent vaccine (6/11/16/18) in preventing HPV infections at anal and oral. This result is quite different from the previous knowledge. HPV is a large family of non-enveloped DNA viruses and high risk types are proved oncogenic potential for infection-related

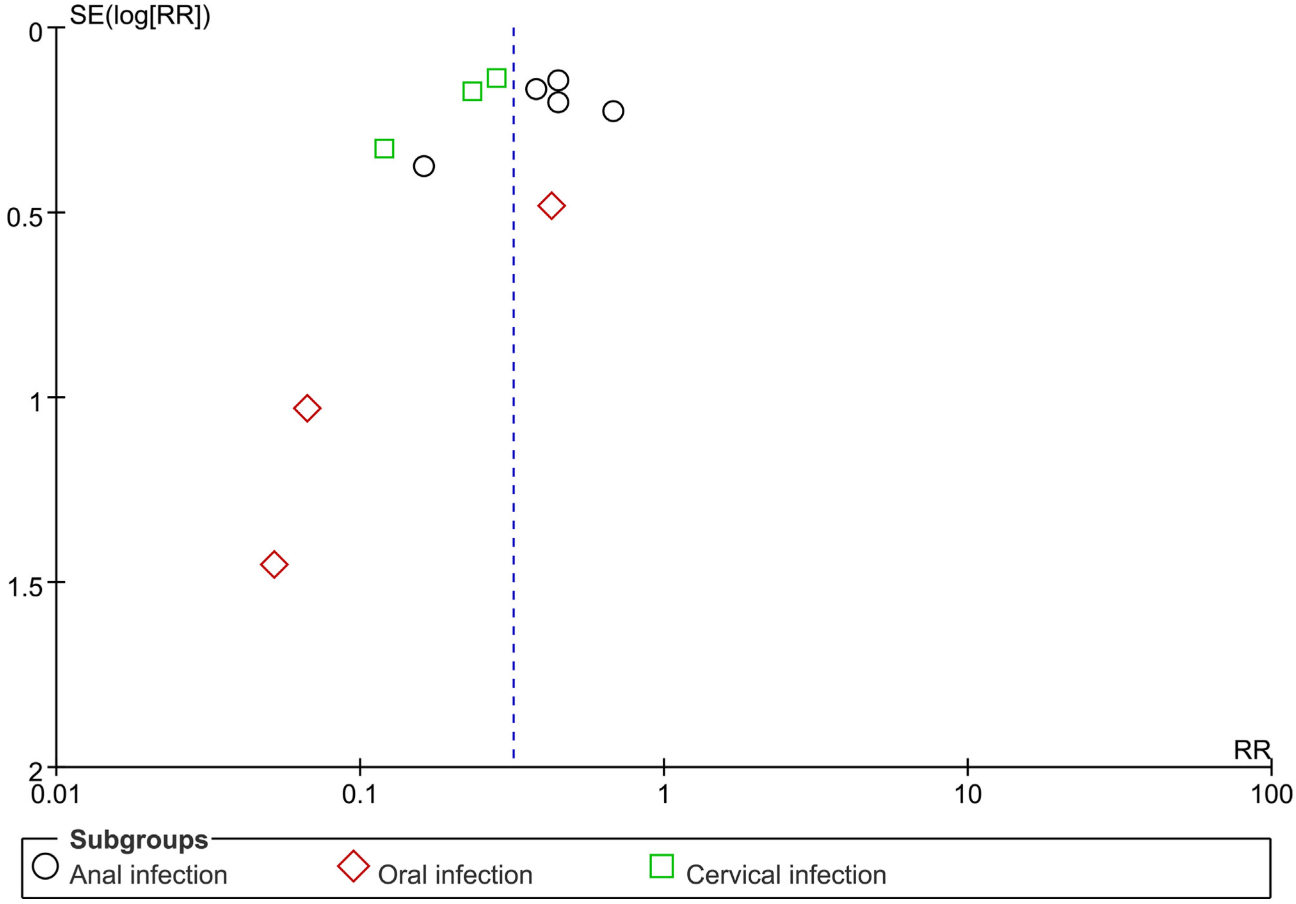


Fig. 6. Funnel plot for assessing publication bias. RR, risk ratio.

cancer on account of oncoproteins E6 and E7.[2,51,52] The protective range of bivalent vaccine is less than the quadrivalent vaccine or 9-valent vaccine undoubtedly. More than 200 types of HPV were identified; most of people would believe extensive conservation means less chance of infection. But interestingly enough, the study shows that the bivalent type is more effective at anal or oral.

To analyze the reason, the data volume in this study may not be typical enough for the macro situation of HPV infections as there were only five articles were adopted. First, the geographic coverage of these five articles is limited to the USA or Europe, epidemic tendency of HPV in this research may be not typical and intact. In other words, if HPV type 16 or 18 is predominant in these areas, the advantaged of tetravalent vaccine is faded. Second, oral or anal HPV infection is high-incidence in faggotry or bisexual,[20,45,46,53] but it is a pity that this population lacks social recognition and humanistic care, the acceptability or percept to HPV vaccination and the access to health services is not optimistic.[35,36] It may cause deviation to the incorporating data because of the difficulty of information collection from this population. Third, exfoliative cytology is wildly used for cervical cancer screening, but it is not extensively used at anal or oral, at least not in many developing countries. Last but not least, it may be caused by immunologic or biochemical factors. Once vaccines were injected into human body, a series of complicated biological process, including but not limited to immunogenicity, recognition, antigen presenting, adjuvants, response, and more, would actively start. All these processes could play a major role on vaccination indisputably,[54,55] this study may be a enlightenment to lucubrate the immune effector mechanisms of HPV at anal or oral.

This study reaches an unforeseen conclusion, with some limitations. First, in the review process, owing to the possibility of incomplete database search, some key research studies also were omitted. Moreover, the language of this article is limited to English, so literatures published in other languages are not considered. Our review included only five articles; the funnel plot was drawn but discarded the Egger test. The Egger test power is feeble for detect publication bias when scarce articles were included in the meta-analysis.[41,56] This limitation may cause publication bias, it is required to retrieve more research about HPV or find new approaches[43] to avoid obvious publication bias in further studies. Moreover, HPV relates to squamous epithelium, only vaccination efficacy against HPV infection at cervical, anal, and oral were analyzed, without including the gastrointestinal tract, penis, head, neck, or more, due to the adequate data.[12,48,57] Last but not least, HPV is closely associated with carcinoma whereas it is failed to retrieve enough researches on vaccination with any relevance to carcinoma.[49,58]

To conclude, HPV vaccination could effectively block the HPV infection at cervical, and also anal and oral and would be an effective method for cancer prevention.

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None declared.

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Original Research

The relation between the social and the biological and COVID-19

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ABSTRACT

Social factors have been linked to disease severity and mortality in COVID-19. These social factors are ethnicity, social disadvantage, age, gender and occupation. Pre-existing medical conditions have also been identified as an increasing risk. This paper explores the relationship between these social and biological factors using a syndemic frame of reference. The paper argues that although the associations have been very well documented, the mechanisms linking the social factors and disease outcomes are not well understood. An approach that seeks to find commensurability between the social and the biological, is suggested.

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has revealed an important gap in the evidence about the links between the disease and socially defined vulnerability, susceptibility and risk. This paper considers this gap and points to a way to re-think the relationship.

Why do some groups get sicker and die in greater numbers?

This paper begins with the perhaps surprising assertion that our understanding of the relationship between social and biological phenomena is limited. We, of course, know a great deal about biological mechanisms and pathology, and that some are triggered by, and often associated with, social phenomena.[1–5] However, the way the interface between the social and the biological realms actually works, is not well understood mechanistically.[6,7] So, although factors like chronic stress and inflammation linked to the social position are sometimes pinpointed, the specification of stress as a social phenomenon, involving a transaction between the person and the environment is not elaborated, other than in quite general terms.[8] Most of the focus is on the biological mechanisms, which follow the triggering stressor. The triggering phenomena are treated as if they were quite separate from the biological consequences, rather than in an interactive relationship with them.

Early on in the COVID-19 pandemic and then repeatedly during 2020–2021, in the United Kingdom and elsewhere, the data showed that some social groups were at greater risk of severe infection and mortality than were others. These were the black and minority ethnic community, the relatively poor and disadvantaged, men, certain occupational groups, people with some pre-existing medical conditions and the elderly.[9–20] There is a clear association across different jurisdictions between COVID-19 disease severity and death and social factors broadly defined.

It may, therefore, seem perverse to suggest that we have limited understanding, as the associations are so well established. However, beyond the associations, what of causal mechanisms operating within dynamic interacting systems?[21,22] Public health science has an excellent record of unravelling mechanisms linking toxic environmental exposures and biology, and proximal risky behaviour and disease.[23–25] Its record in respect of the *mechanisms* linking *social life* and the biological is much patchier, even though the associations have been well known since the nineteenth century.[26–28] The descriptions of the precise mechanisms by which the social determinants exert their malign influence is largely absent from the scientific, including the social scientific, literature. This gap is apparent in the respect of COVID-19.

During the pandemic in the UK, there have been numerous policy and managerial admonitions for the system to orient itself to take remedial action in respect of the groups most at risk and the social factors involved.[15] There is good advice about what might be done.[29] However, these efforts have been less successful than they should or could have been. To remedy the situation, we need to

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understand the social better and to learn more about its interactions with human biology.

Understanding the social better

In the UK, and beyond, there are important differences within and between social groups along the dimensions of class, gender, ethnicity, age, geography, sexual orientation, religion and disability.[30–32] These differences in turn intersect and interact with each other through the social practices in which people engage.[33] This produces the rich diversity that is contemporary society. That behavioural variegation—normatively, culturally, socially, economically and geographically—means that there will be differences in access to power and the resources available to people, their abilities to shape their own lives, and to control their lifeworlds. The spread of infection is just one function of the different social practices in which these highly differentiated groups engage.

The complex overlay of social differences and the intersections between them, make up the richly nuanced heterogeneity of the populations. It is at best naïve, and at worst ignorant, to try to think about, model, and act upon the population without reference to this. There is not one British or English, or white, or Scottish, or South Asian, or Black sub-culture. There are myriads of them. It is undoubtedly complex, but not unknowable. Although far from complete, a lot is known about the nature of the different communities and their characteristics in the UK.[34–39] This rich literature demonstrates that it is important not to treat the different ethnic and social class groups as if they were homogenous. Categories like 'BAME' or 'socially disadvantaged' are unhelpful as they imply that the factors at work in the vulnerability, susceptibility, risk and severity are the same for everyone in that group. The data suggest this to be inaccurate. For example, there were differences in the risk of death between the first and second waves of the UK pandemic between the Black African and the Caribbean and the Bangladeshi and Pakistani communities. It was higher in the latter two groups.[40] We have to be much more granular and nuanced.[41] We must be mindful of the rich variegation within, as well as between, communities.

Social variation in the population in the UK, US, much of Europe and beyond is great. Policy actions must reflect that, avoid thinking in categorical terms and start thinking in relational terms.[31,41] Moreover, we have the information, or at least some of it, in the UK and elsewhere. The fact that there is no single pattern within the diverse groups seems to be clear in the data and is actually well-understood.[15] However, even when we have the data, turning that knowledge into action is difficult. Linking it to causal mechanisms remains to be developed.

It is not just the official data and the academic descriptions of communities to which we should turn. Much of the knowledge about the rich variegation and the social dynamics resides in the communities themselves and the local municipalities, the primary care and the public health services that support them, as well as the many small and larger businesses that serve them. The well-worn precepts of health promotion would be the obvious route to follow.[42–44] We need to work with people, learn from them, get to understand their preferences, likes and fears and try to get to grips with their practical knowledge about why they do what they do. We should not 'just do stuff to them', even if that 'stuff' is done with the best of intentions.

This, actually, is also well understood in the official record within the UK. Community asset-based approaches to health promotion were advocated in response to COVID-19 and resources exist to help with this endeavour from the Local Government Association, for example.[12,14,16] There was an official acknowledgement that there might have been systemic service delivery failures to ethnic minority communities.[12] Many Directors of Public Health worked with their local populations and centrally there were well-intentioned aspirations to engage.[15] At the end of July 2020, in a letter to all NHS Trusts, Clinical Commissioning Groups, Community Health Services and NHS 111 and Primary Care providers, Sir Simon Stevens and Amanda Pritchard (NHS Chief Executive, and Chief Operating Officer respectively) urged the NHS to engage with local communities. They advocated protecting the most vulnerable, ensuring services were used by those in greatest need, and targeting long-term conditions.[45] This was followed by a set of detailed instructions on 7th August 2020.[46] The need for preventive efforts, because of health inequalities linked to class and ethnicity and COVID-19 was widely acknowledged, officially and beyond. However, although strong on aspiration, the system-wide changes that were canvassed have not been easy to discern in action. The obvious exception occurred at the end of 2020 when the Joint Committee on Vaccination and Immunisation in the UK (JCVI) identified the oldest members of the population as the first candidates for immunisation.[47]

Putting it together—the syndemic concept

Public Health England identified the factors leading to a greater risk of infection as increased exposure, transmission, susceptibility and vulnerability.[48] The phrase 'underlying medical conditions' entered the lexicon of newsreaders and journalists early on in the pandemic, as a catchall to explain the apparent clustering of cases and mortality, especially for ethnic minorities and older people. The implication was that these groups had more underlying medical conditions and that this raised their level of risk and hence their probability of dying.

Anyone with a passing familiarity with the literature on health inequalities would scarcely have been surprised by the data on severe infection and mortality and social disadvantage that emerged in the first months of 2020. The somewhat mysterious 'underlying medical conditions' turned out to be the principal killers of the last 70 years linked to social disadvantage.[48] The conditions were diabetes, hypertension, cardiovascular disease, chronic obstructive pulmonary disease (COPD), chronic kidney disease, obesity, dementia and Alzheimer's disease.[9] There were marked regional variations reflecting different levels of wealth across the country.[49] The data provided a grim vindication of decades of research linking disadvantage to ill health, and particularly the patterning of non-communicable diseases. The data were a chilling reminder of repeated policy failures to deal with health inequalities, or worse, the deliberate pursuit of policies that inevitably made inequalities in health more pronounced. In this regard, policies pursued in the UK since 2010 stand out as ones that have exacerbated inequalities in health.[50]

Where we have data from the modern period, pandemics have always affected the poor more than the well-to-do. There were major inequalities in the 1918 Spanish Flu pandemic within and between countries, with the richer faring better. This pattern was repeated in the 2009 H1N1 influenza epidemic.[51] Villermé, one of the French sociomedical investigators of the nineteenth century, studied the links between social conditions and disease. Villermé suspected working and housing conditions, nutritional status and pre-existing disease were the culprits. He wrote in 1833 'epidemics everywhere strike the destitute or miserable classes much more than they do persons of quality'.[26] Not perhaps the language we would use today, but the point is that the pattern we have seen with COVID-19 is not new. The current links between disadvantage and epidemic mortality were in fact highly predictable, and given the ways that life expectancy had stopped increasing in recent years in the UK—a proxy for worsening health inequalities—it was probably predictably worse than it might otherwise have been.

However, it was not just that the pandemic was an overlay on and an exacerbation of existing inequalities, the link to existing medical conditions is important. The pattern of pre-existing morbidity in the populations where mortality has been highest from coronavirus was already reported in the literature. The link between non-communicable diseases and viral infection has been called a syndemic one '… the concentration and deleterious interaction of two or more or diseases or other health conditions in the population, especially as a consequence of social inequality and the unjust exercise of power'.[52] The connection between SARS—a coronavirus—and age, diabetes, hypertension, coronary artery disease and COPD, involving a *three-way interaction* between the viral and other pathologies *and* social disadvantage was well known.[52] That the same process was at work in COVID-19 was noted early on.[49,51,53] The syndemic intertwining of interactive, cumulative consequences, which exacerbated population and individual disease burden, was clear to see.[54]

11 years before the current pandemic, Singer had described the relationship between a coronavirus, non-communicable disease and disadvantage *in a textbook*. The published papers on which he based his argument were widely available.[55–59] The evidence that there was a highly predictable additive effect of disadvantage, pre-existing non-communicable disease and SARs viral infection was in plain sight. Modellers and commentators were well aware of the interaction with the virus[60] and with ethnicity.[10] Moreover, a lot was known about health inequalities, which *a priori* would have suggested that the population would be differentially affected. The clustering of negative syndemic factors in the black and ethnic minority community, the poor and socially disadvantaged, and the elderly created a perfectly predictable storm. Worryingly during the current pandemic, a lot of effort has gone into re-describing this problem, rather than getting to the root of it.

Nevertheless, the idea of syndemic is a helpful way to frame our future thinking and link back to the points above, about the relation between the social and biological. Singer's explanation is useful. "Human environments, including the prevailing structures of social relationships (such as social inequality and justice) and also sociogenic environmental conditions (for example hazards of the built environment, sales of toxic commodities, pollution, species loss and climate change) contribute enormously to both disease clustering and interaction'.[52] The important thing is not only to conceptualise these as *risk factors*, but also as phenomena interacting with the virus. The interactions between the virus, other diseases and inequalities need to be conceptualised in terms of the simultaneous interactive causal mechanisms involved. Associations statistically and epidemiologically and the identification of risk are the starting points, but further elaboration of sociobiological mechanisms is necessary.[61]

The syndemic idea is that human biology is not only affected by interactions between viral infection and pre-existing medical conditions, but the manifestation of the disease is a function of *simultaneous interactions* with the social environment. That social environment consists of social practices in local communities, the material and economic conditions in which people live and work, as well as their subjective experience of all of these things. The key idea is *simultaneous interactions in an open system.*[62] The individual pathology of course attracts attention, but the other dimensions in the system are not merely context. They are part of the multiple pathways of the origins and manifestations of the disease, of vulnerability susceptibility and protection.

We also need to be mindful of the salutogenic possibilities.[63] In other words, what were the protective factors? What are the things that seemed to have conferred social as well as biological immunity? Why is the pattern of the disease so different between different people, so severe in some cases but less so in others? What are the mechanisms at work for those who came out relatively unscathed? Furthermore, are the protective mechanisms merely the inverse of pathogenesis? Or, do the protective measure processes operate through a different causal pathway? Gender, class and ethnicity and age may well be protective for some, but why and how? Broad ecological associations do not explain the phenomena.

All of that is very complex, but is not unknowable. The implication is clear. Unravelling the mechanisms at the *social and biological interf*ace is critical. The frameworks describing social practices, of the interactions between human agency and social structure, are very well-established in the social scientific literature and are potentially helpful.[64,65] The way people live their lives—their actions, habits and skills—becomes deeply ingrained socially *and biologically*. These everyday actions have biological consequences with respect to good or poor health. Human biology or human health, in turn, constitute the capacity and capability to shape and constrain one's own life.[66] The dynamic interactions between agency and structure interact for good and ill with human biology. The constantly recurring interactions between the social, biological and physical worlds and the human subjective experience of them, affect everyone but in different and patterned ways.[7] The consequences of the social imprint on the biology of the body and of the constraints, which, the biology places on social life, are not metaphors. They are phenomena, which are biologically and socially real with mechanisms of interaction. Although beyond the scope of this paper, it is not in principle difficult to map these.

Discussion

There have been no shortage of critics of the policies pursued in the UK and elsewhere and the manner of their implementation. The purpose here is not to add to that chorus, but rather to consider the kinds of ways we should develop the idea of syndemic interactions; use the evidence we already have to do so; and use our scientific knowledge and that of communities, to get it into practice.

The social–biological interaction and in turn its interaction with health services and social care provision may be thought of as a complex open system with continuous interactions between the physical, material and ecological environment, social relations and practices, subjective experience and cognitive processes, and human biology. Systems have emergent properties.[67] In the interactions in the system, no single dimension has precedence. To grasp this requires a commitment to non-reductionist thinking.[68] There also needs to be an acknowledgement that these social factors are not mere background or context, but are intrinsic to the causal mechanisms and interactions involved, and that we have ways of describing those interactions. This is important. The biological, whether microbiological, genetic or atomic, is usually foregrounded in medical research, while social, economic and cognitive processes are viewed, at best, as mere context or the origin of risks or stressors, while the primacy of the microbiological is retained. When thinking syndemically, it is more useful to conceptualise the various elements in the system as in constant interaction with each other.

So, for example, although there is clear evidence that certain aspects of the way the pandemic has evolved are associated with structural racism, the epistemic bases (the knowledge admissible as an adequate explanation), for accounting for the phenomena of racism and its effects on health, are quite different to, for example, the grounds of proof in a biological model of way T cells respond to infection. If we stay in our silos and do not try to understand the mechanisms involved in each of these domains *and how they* *interact with each other*, the only outcome is likely to be the feeling that there is epistemological incommensurability—a high sounding way of describing mutual incomprehension. Soft systems thinking, instead of silo thinking, allows the totality of the problem to be conceptualised as a whole. It involves investigating interactions that are not yet, well understood.

And despite everything, I sense from the public record that we are almost there. There was clearly considerable effort across the UK government, its Arm's Length Bodies, and the research community to draw together the data relating to ethnicity and to inequality more generally.[69] Much research was commissioned to support this and to fill gaps in the evidence base. However, it mostly remained locked in the language of describing the problem and identifying risk with a strong biomedical primacy.

Conclusion

Several researchers working in a syndemic frame of reference have begun to hypothesise the pathways and mechanisms between COVID-19 (and other viral infections), pre-existing disease (especially diabetes and cardiovascular disease) and social structures including ethnicity.[70–74] This work is important, as the absence of detailed understanding, especially of the interaction with the social, has significantly hindered the ability of jurisdictions across the world to respond forensically and effectively to the pandemic. Future responses to similar viral infections will be considerably enhanced, by such understanding. These hypothetical pathways will need to be explored in full, including systematically interrogating the extant literature as well as new primary research to test them.

In scientific terms, so far so traditional! However, the arguments presented in this paper carry a health warning about the conceptual structures to be used in hypotheses development and testing. With respect to COVID-19, the syndemic account must involve several elements.

First, we must focus on the repetitive, recursive features of people's lives *pre-pandemic(s)*. These are important in two different respects in understanding the dynamics involved. (i) The recursive nature of social interactions across the life course leave their marks on the human body. Metabolomics and other omics show how life literally gets under the skin.[7] The conditions, which have been so deadly in COVID-19 (diabetes, heart disease, dementia etc.), follow this process. (ii) The same practices that operate across the life course also operate in the here and now; at work, in the home, in the community, on public transport and so on. They are the vectors of viral infection. The practices are the gateway to the molecular structure of the human body, already damaged and made susceptible by those same practices. The social practices of the communities most at risk must be an urgent research priority. Importantly, academic researchers must not assume that they know how these communities live; they must let the communities themselves tell them.

Second, to understand practices, attention must be directed to the relational nature of social phenomena. The focus must not be on individuals and their behaviour, but on collective activities. The social phenomena, which the epidemiology has so clearly revealed as risks and vulnerabilities, must not be treated as people's individual characteristics. To do so easily leads to victim blaming and often ill-considered strategies to bring about individual behaviour change.[75] They must be conceptualised instead as dynamic relationships and interactions, operating at the group level.[41] The essence of ethnicity, gender, sexual orientation, class, occupation and age is not that they are things or labels that we can attach to individuals. Relationally, they are about the experience of being black, gay, a woman, poor and old. It is not being Bangladeshi or Black that is important. It is the nature of the social relationships involved in these social placements, at work, at home, in the community—that defines the noxiousness or otherwise of the lives people lead and their abilities to control their own lifeworlds. Those experiences involve power, conflict and social exclusion, as well as more nurturing relationships. What makes us human is not our individuality, but our social relations with others. So, we must move away from concepts that are individually oriented to ones that are relationally oriented, and are dynamic not static. In research terms, we must move beyond variables and factors and instead look at the lives that human beings lead with other human beings.

Third, we must identify the competencies and capabilities people have, the sense they make of their lives and the physical infrastructures around them, which constrain and facilitate the things they are able to do. In empirical terms, this means going granular and going local, and foregrounding the kinds of community studies that can do precisely this. We will need to understand the history of locales and communities and, very importantly, the understandings that communities have of their own histories. This may sound like a tall order, but in the UK at least, the kinds of things referred to here are the meat and drink of local public health and primary care teams. This kind of knowledge must not be relegated to second place behind epidemiology, modelling, virology, immunology and clinical medicine; it must instead be the starting point and at the very least as an equal partner with the biomedical sciences.

Fourth, we must think upwards to the complex open system that is human health and disease. The COVID-19 pandemic vividly illustrates that human health and disease involve multiplex interactions and relations between physical, material, political, economic and ecological environments, social and cognitive life and human biology. If we ignore this, and seek to analyse these things in a reductionist and isolated way, our understanding will only ever be partial, and we will never unravel the complexity nor see that complexity from the point of view of the people whose lives have been so desperately perturbed in the pandemic. Unfortunately, much of the science about COVID-19 has been highly discipline specific. It represents the viewpoint of the scientists, policymakers and politicians—not the communities themselves. The starting point is to be in, and work with, the communities whose lifeworlds have been cruelly ransacked by COVID-19. We need to work to enhance capabilities—biologically, socially and economically—capabilities that are the source of current and future social and clinical vulnerability.

Finally, we must stop using terms like wider determinants or social causes, carelessly. This is because too often these terms are operationalised heuristically—as shortcuts in understanding and explanation.[76] We must instead use the clues revealed by the wider determinants and social causes literature. These signpost the mechanisms that reveal the pathways to individual and community health outcomes. We know a lot biologically about some of the mechanisms involved in COVID-19. We know a good deal about social life too. But the two lots of knowledge remain in separate domains. Metaphorically, many of the pieces of the jigsaw puzzle are there already. We have yet to fit them together. The problem is that unless we conceptualise things along the lines suggested in this paper, we will forever keep the jigsaw puzzle, not just in its box, but in separate boxes of scientific silos. We will continue to spend our time staring at the underside of the box, rather than its top. The top of the box, of course, has the picture to guide the way we fit the pieces together. The picture is the reconceptualising suggested here.

Author statements

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Original Research

Towards transforming community eye care: an observational study and time-series analysis of optometrists' prescribing for eye disorders

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ABSTRACT

Objectives: This study aimed to provide evidence on the therapeutic prescribing activity by community optometrists in Scotland and to determine its impact on workload in general practice and ophthalmology clinics.
Study design: Scottish administrative healthcare data for a 53-month period (November 2013–April 2018) were used to analyse non-medical prescribing practice by optometrists.
Methods: Using interrupted time-series regression (Autoregressive Integrated Moving Average), we assessed the impact of optometrist prescribing on ophthalmology outpatient attendances and general practice prescribing for eye disorders.
Results: A total of 54,246 items were prescribed by 205 optometrists over the study period. Since the commencement of data recording, optometrist prescribing activity increased steadily from a baseline of zero to 1.2% of all ophthalmic items prescribed. Neither the monthly number of items prescribed nor the size of optometric workforce were associated with a reduction in ophthalmology outpatient appointments over time.
Conclusions: Optometrists increasingly contribute to community ophthalmic prescribing in Scotland, releasing capacity and lessening general practice, but not secondary care workload. There appears to be an underutilisation of optometrists related to the management of dry eye, which represents an opportunity to release further capacity.

Introduction

Population growth, increasing life expectancy and a shift of illness patterns from acute to long-term conditions and multimorbidity is increasing demand for health and eye care services globally.[1–4] Recent global estimates indicate that health systems and eye care providers in particular will face significant challenges related to an increasing prevalence of visual impairment, with the number of blind people projected to be 38.5 million by 2020 and 115 million worldwide by 2050.[3] In order to mitigate the anticipated rise in visual impairment, the WHO has developed a global action plan for universal eye care[5] that includes recommendations relating to more closely integrated eye care services to ensure comprehensive care.[6] In the UK, a considerable rise in sight-threatening conditions such as glaucoma (49%), cataract (52%) and neovascular age-related macular degeneration (64%) have been predicted by the year 2035.[7] Non–sight-threating conditions such as dry eye are also common among the older populations.[8] Short-term initiatives such as waiting time reduction programmes are unlikely to be sufficient to resolve long-term increases in demand.[7]

To respond to the increasing demand for eye care and improved timeliness and patient access to medicines, some countries such as the UK have developed strategies to shift certain types of clinical care from hospital to community settings.[9,10] This includes the introduction of non-medical prescribers (NMPs) to healthcare systems, where autonomous prescribing authority is delegated to non-medical professionals such as nurses, pharmacists and optometrists.[11,12] Following a government-commissioned review of prescribing,[13] independent prescribing authority was extended to UK optometrists in 2008, with the specialist prescriber register

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0033-3506/

launched in 2009. Until then, people experiencing eye problems that required care were managed by their general practice or in secondary care, but the new framework allowed optometrists to autonomously manage eye conditions in the community.[14] In order to qualify as optometrist independent prescriber (OIP), optometrists are required to have a minimum of two years clinical work experience, to undertake three postgraduate modules in therapeutic prescribing, to complete 24 clinical hospital sessions under the supervision of an ophthalmologist and to pass a common computer-based assessment.[15]

Evidence from other clinical areas suggests that NMPs in nursing and pharmacy provide services that result in more timely and efficient care.[16,17] A recent Cochrane review suggested that NMPs can deliver comparable patient outcomes such as in the clinical management of hypertension, hypercholesterolaemia, diabetes and medication adherence as well as improved patient satisfaction and quality of life. No studies on optometrist NMP practice were identified as part of this review,[18] but scope of practice patterns of NMP by optometrists have been assessed in studies from Australia,[19] Canada[20] and New Zealand.[21] While general practice faces an increase in demand for primary care, leading to higher workloads (overburden), NMP practice has the potential to address the burden on stretched services, to increase overall capacity and efficiency of community health care and to reduce primary care workload, as has been shown for pharmacist NMPs.[16]

Evidence of the impact of NMPs related to other professions (e.g. pharmacy) is becoming more readily available,[22,23] but despite the introduction of OIP a decade ago, there is considerable uncertainty relating to the range of prescribing activity and the clinical and economic impact of OIP practice.[18] Given that both general practices and ophthalmology clinics in secondary care are experiencing continuous increases in demand for eye care services, it would be timely and beneficial to ascertain the impact of OIP practice. This study was designed to provide evidence on community OIP practice in Scotland between 2013 and 2018, i.e. for a period unaffected by the COVID-19 pandemic, and to determine its impact on i) general practice eye care–related workload and ii) ophthalmology outpatient workload using Scottish administrative healthcare data.

Methods

Optometrist prescribing data

Anonymised data were provided by the Information Services Division (ISD) of NHS National Services Scotland[24] (now part of Public Health Scotland) for the period of November 2013 to April 2018 on all items prescribed by optometrists holding an independent prescriber qualification. Prescribing data were available by month and by OIP practitioner working in NHS Health Boards in Scotland.[a] Individual level data were aggregated to represent the number of items reimbursed per health board and per calendar month. Data from optometrists who were not qualified independent prescribers were not included in this administrative dataset and are therefore not available for analysis.

General practice prescribing data

General practice prescribing data were obtained from ISD for the period October 2015 to April 2018 for all general practices in Scotland and were used to calculate the combined total of all OIP and general practice prescribing for eye conditions. Owing to the shorter time period for which general practice data were available, comparison with OIP was made only for this period (October 2015 to April 2018).

Ophthalmology outpatient data

Data on routine monthly attendance at ophthalmology outpatient clinics were obtained for all NHS Health Boards in Scotland from ISD for the period of November 2013 to April 2018. Data were reported as being 98%–99% complete.[25] Information from NHS Orkney, NHS Shetland and NHS Western Isles were excluded to ensure comparability with OIP data.

Types of medicines analysed

The analysis focussed specifically on OIP and general practice prescribing activity relevant to eye care and was limited to eye-related medicines specified in section 11 of the British National Formulary (BNF) and eye products listed in BNF (pseudo) section 21.[26]

Sub-group analysis and exclusion

We carried out a sub-group analysis to assess prescribing patterns for ocular preparations of antibacterials, anti-inflammatories and dry eye treatments. Prescriptions relating to items which were clearly unrelated to ocular disease were excluded from the analysis (0.6% of all items).

Statistical analysis

Descriptive statistics were generated for prescribing activity of OIPs over time and by NHS Health Board area. OIP prescribing activity was measured as the percentage of all eye-related prescribing (total number of items prescribed by OIP and general practice). Attendance rates at ophthalmology outpatient clinics are presented per 100,000 population.

We used interrupted time-series regression with Autoregressive Integrated Moving Average (ARIMA) errors to assess the impact of two independent variables: i) the number of items prescribed by OIPs and ii) the number of active OIP practitioners on the number of patients seen at ophthalmology outpatient clinics in NHS Scotland over a 53-month period. The analytic strategy consisted of initially modelling the ophthalmology outpatient clinic attendance data time-series to obtain an adequate preliminary model and then testing the effect of the two independent variables. Several models were developed, and the most parsimonious model was selected using the Akaike Information Criterion. The effect of OIP prescribing activity (number of items prescribed per month) and the number of active OIPs at each month were tested separately using the best fitting model. The analysis was carried out using the Stata SE v15 software package (Stata Corp, College Station, TX).

Ethics statement

As data were non-identifiable administrative prescribing data, ethical approval was not required.

Patient and public involvement

The data used were national administrative healthcare data, and patients were not involved in this study.

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[a] Data were not available for two health boards, NHS Orkney and NHS Shetland, as there was no recorded non-medical OIP prescribing activity over the study period. Data from one health board, NHS Western Isles, were excluded from the analysis because of small numbers and to comply with data protection legislation.

Results

Regional distribution of OIPs

A total of 205 OIP practitioners were prescribing in Scotland during the study period. Fig. 1 shows the number of OIP practitioners, calculated per 100,000 population for each local health board. The number of practitioners increased year-on-year, particularly in larger health boards such as NHS Ayrshire and Arran, NHS Grampian and NHS Greater Glasgow and Clyde (Fig. 1).

Quantity of prescribed items, temporal and regional variability

Over the 53-month period, a total of 54,246 items were prescribed by OIPs. A consistent trend of increasing prescribing activity with some seasonal dips was observed (Fig. 2).

Fig. S1 A and S1 B (supplementary files) contrast the trends in the number of prescribed items over time between an urban setting (NHS Greater Glasgow and Clyde) and a rural setting (NHS Highland). The annual prescribed items and the relative differences for all full calendar years are shown by health board (Supplementary Tables 1 and 2, respectively). Overall, prescribing activity increased across Scotland for each full year reported. Looking at the most recent year-to-year differences (2016–2017), there was a relative increase in items prescribed, ranging from +7% in NHS Fife to +160% in NHS Borders. A reduction in prescribing activity was observed for a single health board (NHS Forth Valley: −79%).

Comparison of OIP and general practice prescribing for eye disorders

Using the latest monthly data available (April 2018), the 205 OIPs issued approximately 1.2% of all eye-related prescriptions issued by OIPs and general practices combined, with general practice prescriptions originating from 1072 practices. Both the magnitude and the proportion of prescribing carried out by OIPs were relatively low when compared to the volume of prescribing in general practice. However, we observed a steady increase in OIP prescriptions from a baseline of zero, alongside a corresponding decrease in ophthalmic items prescribed in general practice. Between October 2015 and April 2018, OIPs represented approximately 3% of the combined number of general practice and OIP prescribers in Scotland and prescribed 1.2% of all antibacterial items, 2.4% of all anti-inflammatory items and 0.4% of dry eye items. To illustrate the trend in OIP prescribing activity over time, the left-hand side panel of Fig. 3 shows the number of items prescribed by OIPs across Scotland. Timelines are presented in Fig. 3 for antibacterials (Fig. 3A), anti-inflammatories (Fig. 3B) and dry eye treatments (Fig. 3C), indicating an increase in OIP prescribing activity. In contrast, a modest, albeit variable, reduction in the number of items prescribed in general practice for the same groups of items is observed in the right-hand side panel of Fig. 3A–C.

Impact of OIP practice on ophthalmology outpatient clinics: ARIMA time-series analysis

Fig. 4 shows attendance rates at outpatient ophthalmology clinics from November 2013 to April 2018 for each NHS Health Board. The figure serves two purposes. It allows for i) a time-related comparison of normalised outpatient appointments and ii) an appraisal of regional outpatient activity. Comparing year-on-year patterns, we observed a variable pattern of outpatient activity across Scotland, with a steady decrease of outpatient attendances in some areas (e.g. NHS Grampian, NHS Borders and NHS Lanarkshire). The focus of this analysis is on the five full calendar years of data (2013–2017; indicated by 2013-navy; 2014-burgundy; 2015-green; 2016-orange; 2017-mint). Data for 2018 (red) represent incomplete data because of lack of data availability but are shown to allow for the normalised regional comparisons between health board areas per 100,000 population. This comparison is still valid as the cutoff point was identical across all health board areas.

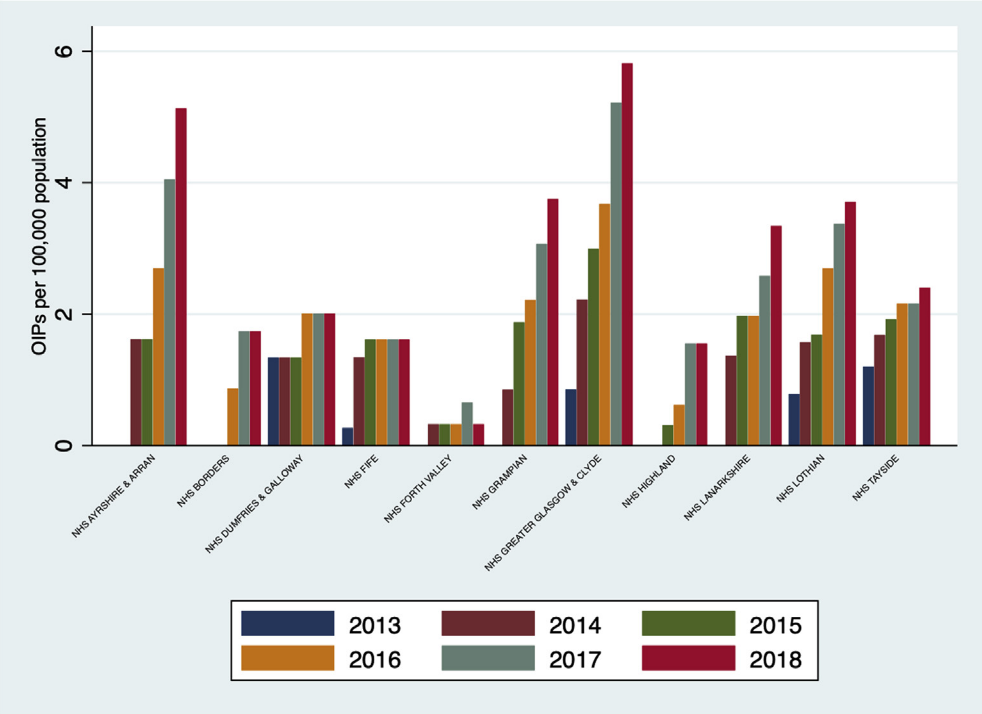

Fig. 1. OIP workforce numbers per 100,000 population by NHS Health Board over time. OIP, optometrist independent prescriber.

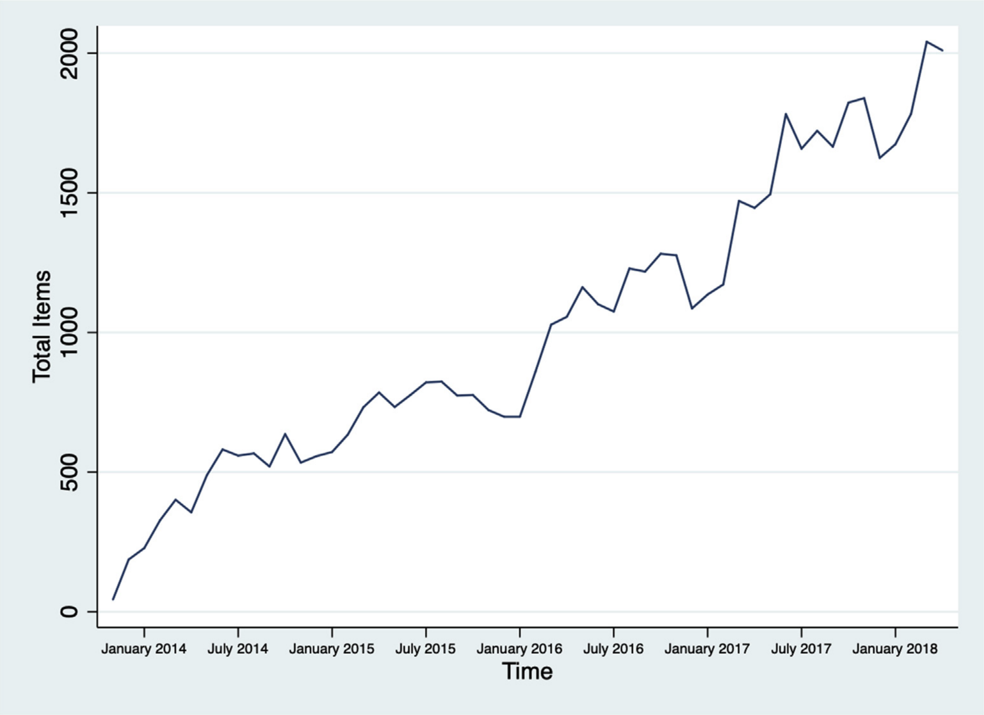

Fig. 2. Monthly items prescribed by OIP practitioners, Scotland, 2014–18. OIP, optometrist independent prescriber.

Time-series analyses were undertaken for the whole of Scotland. The final fitted model was an ARIMA with one regular autoregressive term and first order differencing, with 53 observations (months). The analysis for the association of ophthalmology outpatient appointments and the number of items prescribed by OIPs per month found a small but clinically irrelevant increase in ophthalmology outpatient appointments over time (0.08%; confidence interval [CI], 0.03%–0.14%; $P = 0.004$; Table 1). Similarly, the size of the OIP workforce was not associated with a reduction in ophthalmology outpatient appointments, with both the point estimate of the effect size and bounds of the CI excluding a negative association (1.0%; 95% CI, 0.34–1.86%; $P = 0.004$). With the slight 1.0% increase in outpatient attendances, it is, at present, not likely that OIP practice is causally related to any change in hospital workload. However, analyses by Optometry Scotland show that the increase in hospital appointments has increased at a lower rate in Scotland than in England (unpublished data), and OIP practice may have contributed to this lower rate of increase.

Discussion

Main findings of the study

This study provides, for the first time, a quantitative time-series analysis of optometrist prescribing in Scotland in relation to general practice and outpatient activity using NHS administrative data. Non-medical prescribing capacity in Scottish community eye care has increased steadily since data recording began in 2013 and continues to develop. Our findings suggest positive effects of OIP practice, e.g. optometrists contributing to lessening the burden in primary care, and a modest reduction in general practice prescribing for eye disorders. This observation suggests a release of capacity and therefore a positive impact on workload in general practice. The outcomes of our study suggest that, rather than contributing to a shift of eye care from secondary to primary care, there is a (slow) shift occurring within primary care, i.e. from general medical practice to optometric practice. Given the demand and workload challenges in general practice, such a shift is desirable and has the potential to release additional general practice capacity in the long term.

What is already known on the topic

OIP has been introduced in a number of countries, including Australia, Canada, New Zealand and the USA.[19–21,27] In Australia, a scope of practice survey indicated that just under half of responding optometrists were licensed to prescribe medicines in the community. The most commonly prescribed groups of drugs included dry eye treatment, decongestants and antiallergic medications, but there were low rates of prescriptions for anti-infectives.[19] Since 2011, community optometrists in Ontario, Canada, have been managing patients before referral to hospital eye services, with 6% of referred patients being on a prescription medication issued by optometrists. As in the UK, there are few restrictions regarding the clinical circumstances under which optometrists are allowed to prescribe for ocular disorders.[20] In New Zealand, which is comparable to Scotland in geographic diversity, population figures and the publicly funded healthcare system, non-medical prescribing has also been implemented. Most optometrists in New Zealand practice in the community, but an overarching NMP policy that allows for safe and sustainable delivery of NMP services was recently still to be developed (2017).[21] In the UK, OIP training takes place at the postgraduate level, whereas optometrists in New Zealand gain prescribing authority as part of their undergraduate training/prequalification training, and 66% of all optometrists are optometrist prescribers.[21]

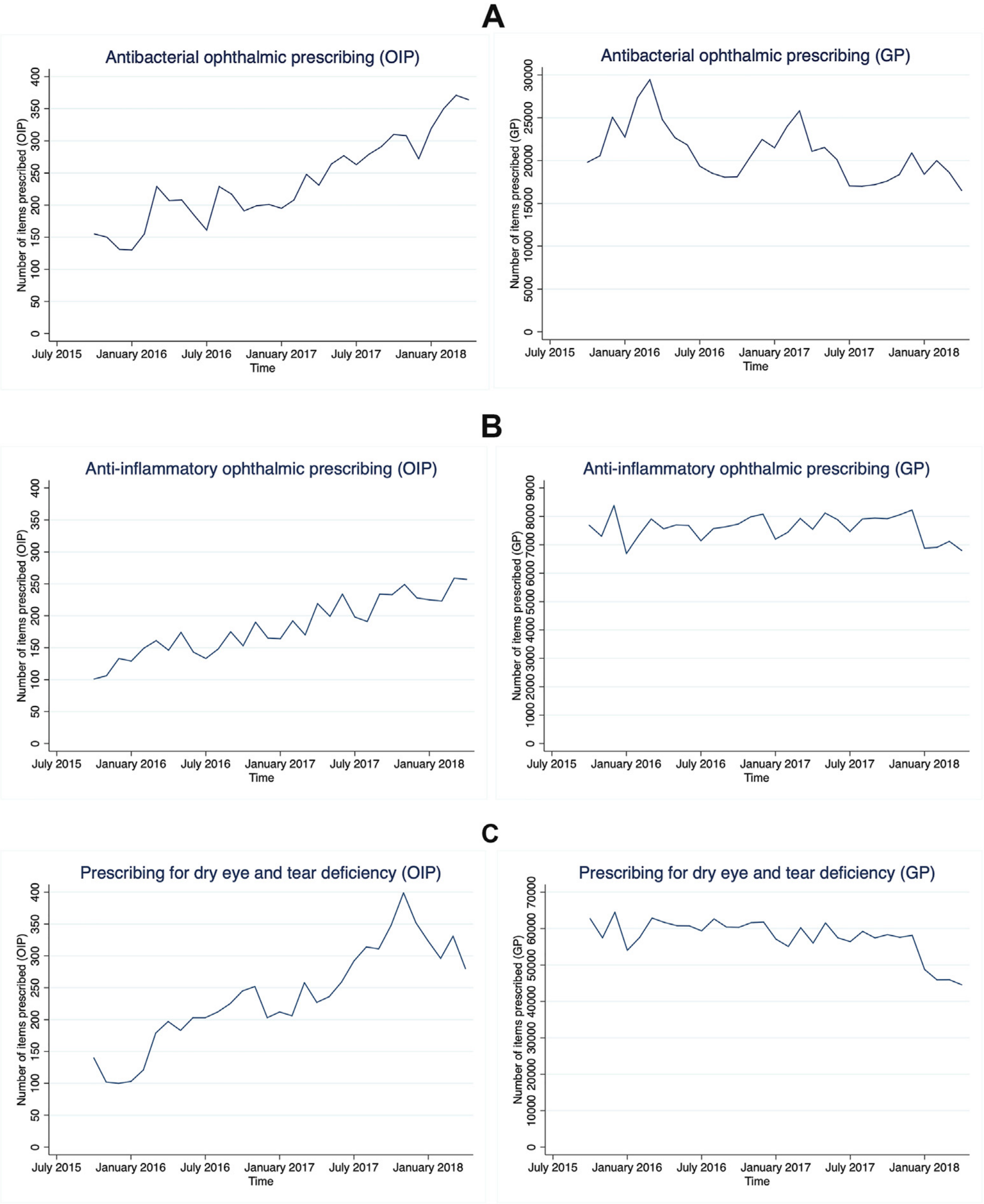

Fig. 3. A. Antibacterial ophthalmic prescribing (number of items) by OIPs (left) vs general practice (right). B. Anti-inflammatory ophthalmic prescribing by OIPs (left) vs general practice (right). C. Prescribing for dry eye and tear deficiency by OIPs (left) vs general practice (right). GP, general practice; OIP, optometrist independent prescriber.

Underutilisation of optometrists in the treatment of dry eye and transfer of care

One group of ophthalmic items commonly prescribed in general practice were dry eye related. While the overall proportion of items prescribed by optometrists is gradually increasing, there appears to be underutilisation of community optometrists in the management of dry eye. Even though a proportion of patients with dry eye will obtain lubricants classified for pharmacy sales without the need for a prescription, a further reduction in dry eye–related workload in general practice would release additional capacity and could be achieved by transferring the care of patients with dry eye to community optometry. Optometrists are well placed to manage these patients, allowing general practices to dedicate consultation time to patients with more severe conditions. However, many patients will be attending general practice for non-ocular morbidity and mention dry eye as one of several concerns, thus allowing general practitioners (GPs) to prescribe dry eye treatments alongside any systemic medication that may be required.

A transfer of care within primary care is already under way, partly facilitated by the new (2006) ophthalmic contract in Scotland[28,29] and partly through locally organised enhanced eye care schemes in which accredited optometrists may prescribe/supply without being qualified NMPs. Notwithstanding, a larger scale transfer of care would require careful impact analysis, which is beyond the scope of the present article. Factors that would need to be considered include economic aspects and viability for general practice, patient access and structural factors such as the capacity of OIPs to issue repeat prescriptions. However, if primary care, optometry, commissioners and policymakers agree that such change continues to be desirable, the patient-centred service and pathway changes will require time to reach maturity.

In contrast to the observed effect of OIP on general practice, we did not find robust evidence that the number of items prescribed or the number of active OIP practitioners had a measurable effect on the number of ophthalmology outpatient

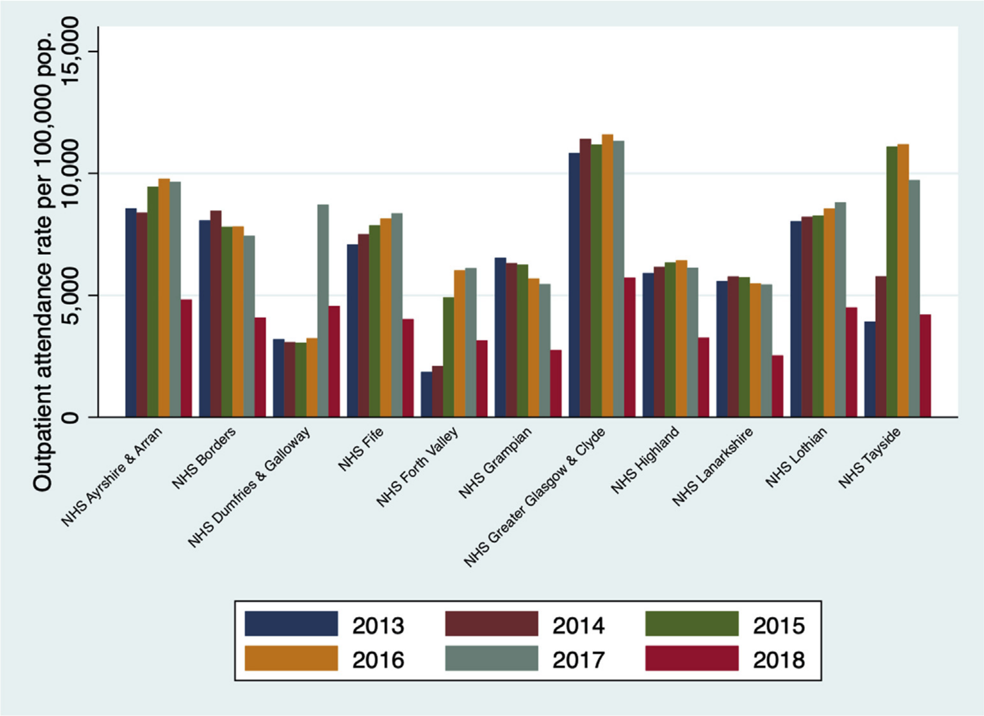

Fig. 4. Attendance rate at outpatient ophthalmology clinics per 100,000 population by NHS Board.

Table 1
Outcome of ARIMA model for two independent variables: i) number of items prescribed and ii) number of OIPs. Akaike Information Criterion

ARIMA model	Estimated effect (%)	95% CI	*P* value	AIC	Adjusted R^2
Number of prescribed items	0.08	0.03 to 0.14	0.004	−44.54	0.67
Number of OIPs	1.00	0.34 to 1.86	0.004	−38.29	0.64

AIC, Akaike Information Criterion; CI, confidence interval; OIP, optometrist independent prescriber.

appointments. This may change in the future when community optometrists become more involved in the management of patients with potentially sight-threatening ocular disease such as glaucoma.

Aspects related to demand for OIP in the UK

As in general practice, increasing demand on ophthalmology outpatient services suggests that changes in the organisation of care are required. The introduction of NMP for optometrists reflects not only a response to the need for a change to eye care service delivery but also the need to respond to demographic and workforce changes such as longer life expectancy and the fact that substantial proportions of healthcare workers, including GPs and ophthalmologists, are reaching retirement age. At hospitals across the UK, ophthalmology services accounted for nearly 10% of all secondary care outpatient appointments and for approximately 6% of surgical procedures.[30]

This study suggests that OIP practice has positive effects in that it can release capacity in primary care ophthalmic prescribing. However, even though there has been a consistent increase in activity, the magnitude of OIP practice is still comparatively low when viewed against the volume of general practice ophthalmic prescribing. For this reason, the time-series analysis for the effect of OIP prescribing on general practice prescribing should be repeated in five years' time, when the OIP activity has matured further and prescription rates have increased. Equally, analyses relating to the quality and formulary adherence of OIP practice are needed to ascertain the quality of OIP services.

In the future, further insight into OIP activity and its impact could be gained by validating centralised prescribing data using regional or localised prescribing audits or research studies. Ideally, such smaller scale studies would also consider longitudinal aspects such as OIP workforce trends and the demand for OIP practice.

Study limitations

Our study was limited by the availability of general practice prescribing data (2015 onwards). A further limitation was the unavailability of diagnostic patient-level data, which prevented us from ascertaining with confidence whether disease-specific prescribing recommendations were followed. ARIMA modelling was also attempted using general practice prescribing as the dependent variable. However, the magnitude of OIP prescribing was too small relative to that of general practice prescribing.

Conclusions

OIP practice is making a steadily increasing contribution to eye-related prescribing in Scotland, potentially reducing workload of general practices. Greater utilisation of OIPs for the management of some ocular conditions has the potential to further alleviate demand on general practice. There is limited evidence of an association between OIP practice and hospital outpatient activity. However, this is not unexpected, as subject experts and policymakers have confirmed. In order to assess the quality of OIP practice, patient-level information should be included in prescribing data sets, and the economic impact of OIP practice, which is currently unknown, should be carefully assessed.

Author statements

Ethical approval

Not required due to administrative, secondary health data being used.

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Competing interests

The authors have no competing interests.

In the interest of transparency, the authors wish to note that the employing institution of the corresponding author is a provider of OIP training modules. Many students undertaking these modules receive or have received funding for their training from NHS Education for Scotland.

Authors' contribution

S.J., C.G., C.F., J.L., C.K. and B.M. conceived and planned the study. C.F. and B.M. advised on prescribing practice of optometrists and general practitioners and facilitated data access. R.L. and C.G. conducted the statistical analysis. S.J., C.G. and R.L. drafted the manuscript. All authors commented on the manuscript and approved the final version.

Data sharing statement

Prescribing data for optometrists can be obtained from ISD, NHS Health Scotland, through application and payment of a fee to cover analysts time for data extraction.

Acknowledgments

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2021.04.029.

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Original Research

Trends in under-five mortality rate disaggregated across five inequality dimensions in Ghana between 1993 and 2014

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ABSTRACT

Objectives: Globally, there has been a considerable decline in under-five mortality in the past years. However, it remains a critical issue among low- and middle-income countries, especially in sub-Saharan Africa. In Ghana, under-five mortality is a critical public health issue that requires national interventions. In the present study, we examined the trends of under-five mortality in Ghana from 1993 to 2014.

Methods: Using the World Health Organization's Health Equity Assessment Toolkit, we analyzed data from the 1993–2014 Ghana Demographic and Health surveys. We disaggregated the under-five mortality rate by five equity stratifiers: wealth index, education, sex, place, and region of residence. We measured the inequality through summary measures, namely difference, population attributable risk, ratio and population attributable fraction.

Results: In 1993, under-five mortality among children in poor households (172.90, uncertainty intervals [UIs = 153.21–194.53]) was more than twice the proportion of children from the richest households who died before their 5th birthday (74.96; UI = 60.31–92.81) and this trend continued until 2008. However, in 2014, the poorest had the lowest rate (30.91, UI = 78.70–104.80). Children of women with no formal education consistently recorded the highest burden of under-five mortality. Although in 2014 the gap appeared to have narrowed, children of mothers with no formal education record the highest under-five mortality rate (91.61; UI = 79.73–105.07) compared with those with secondary or higher education (54.34; UI = 46.24–63.77). Under-five mortality was higher among rural residents throughout the years. Men repeatedly had the greatest share of under-five mortality with the highest prevalence occurring in 1993 (137.52; UI = 123.51–152.85) and the lowest occurring in 2014 (77.40; UI = 69.15–86.54). The Northern region consistently accounted for the greatest proportion of under-five mortality.

Conclusion: Ghana has experienced a decline in under-five mortality from 1993 to 2014. Context-specific appropriate interventions are necessary for various disadvantaged sub-populations with risks of health disparities.

Introduction

Globally, there has been a considerable decline in under-five mortality over the past few years. However, it remains a critical issue among low- and middle-income countries (LMICs), especially in sub-Saharan Africa (SSA), where the rates have been higher, compared with those of other regions.[1,2] In 2018, the global under-five mortality rate (U5MR) was 39 deaths per 1000 live births, which represented a 59% global reduction from 93

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deaths per 1000 live births in the 1990s.[3] Differences exist in this reduction across countries. However, the Sustainable Development Goal three (SDG 3) targets two aims at reducing the rates of under-five mortality to 25 or fewer deaths per 1000 live births by the year 2030.[3–5]

There has been a significant reduction in global under-five mortality, but the rate is still high in SSA. In SSA, the U5MR was 78 deaths per 1000 live births in 2018.[3] This means that one of every 13 under-five children in SSA died before their fifth birthday.[3] Ghana's U5MR declined from 110 deaths per 1000 live births in 1993 to 70 deaths per 1000 live births in 2014.[6] However, this decline failed to meet the target action set in Ghana by Under-Five Child Health Policy 2007–2015 that aimed at reducing under-five mortality to 40 deaths per 1000 live births by 2015.[6]

U5MR has received scholarly attention in the past two decades in SSA and Ghana.[1,7–10] The focus of previous studies from Ghana on U5MR was on predictive modelling and identification of relevant correlates.[1,7–10] These studies have identified the following socioeconomic, demographic and biological factors as significant predictors of U5MR: child age and sex, maternal age and education, place and region of residence, household level factors such as wealth index, sources of drinking water and type of toilet facilities.[1,7–10] From these studies, the correlates that consistently explained the variability in U5MR were gender of the child, urban-rural residence, household wealth quantile, maternal education and region of residence.[1,7–10] Given that modifying the effects of these variables on U5MR may lead to significant reduction, development partners, NGOs, and the government of Ghana invest in policies and programs to reduce the risk conditions. Given the limited resources that are available, it is important to know the sub-population that has the highest burden of U5MR and equitably distribute the resources to reduce the burden. However, studies that examined the inequalities in the determinant of U5MR are sparse. Therefore, the present study used the World Health Organization's (WHO) Health Equity Assessment Toolkit (HEAT) software to estimate and highlight the magnitude of inequalities in the following U5MR determinants in Ghana from 1993 to 2014: gender of the child, maternal education, household wealth quantile, urban-rural residence and region of residence. Findings from this study will strengthen and inform appropriate national strategies, interventions, programs and policies to reduce the burden of under-five mortality in Ghana.

Methods

Description of data source

In this study, we used data from five rounds of the 6 Ghana Demographic and Health Surveys (GDHSs) conducted in 1993, 1998, 2003, 2008 and 2014. The 2014 version is the most recent GDHS data set. The Demographic and Health Surveys (DHSs) is conducted across several LMICs across the globe by taking varied information such as under-five mortality, child feeding practices and contraceptive use from women aged 15–49 and their children. The survey adopts a dual-stage sampling approach to select the unit of analysis. The first stage involves the systematic selection of clusters/enumeration areas within rural and urban settings of Ghana. The next stage involves the selection of households within the enumeration areas, selected at stage one. All women and their children within the selected households are deemed eligible to be part of the survey. A detailed description of the survey methodologies can be found in the final reports.[6,11–14] A total of 36,937 child-women pairs participated in this study. Thus, 7194 in 1993, 6290 in 1998, 6991 in 2003, 5617 in 2008 and 10,937 in 2014.

Variables

Dependent variable

The dependent variable was U5MR which is defined as the probability (expressed as a rate per 1000 live births) of a child dying within the first five years of life.

Measures

U5MR was measured for the five-year periods by adopting four (economic status, education, place of residence and region of residence) equity stratifiers. Economic status, a proxy measure using wealth status, is captured by aggregating household assets and computing it into five levels (poorest, poor, middle, rich, and richest) with principal component analysis. The educational level of the mother was measured as the highest level of education attained, which was classified as no formal education, primary education, and secondary and higher education. Place of residence was captured as rural vs urban. Sex of the child was either male or female. Region of residence was made up of the then ten administrative regions of Ghana which included the Western, Central, Greater Accra, Volta, Eastern, Ashanti, Brong Ahafo, Northern, Upper East and Upper West Region. Ghana currently has sixteen[16] administrative regions after recreating 6 new regions from the 10 previously existing regions. The new 16 regions are Oti, Brong Ahafo, Bono East, Ahafo, North East, Savannah, Western North, Western, Greater Accra, Central, Eastern, Upper East, Upper West, Volta, Northern and the Ashanti Region.

Analysis

All the analyses were carried out with the 2019 updated version of WHO's HEAT software (version 3.1) via the WHO Health Equity Monitor database.[15] This was carried out by following two major steps. The first step involved the disaggregation of the U5MR by the four equity stratifiers for each of the survey years (refer Table 1). The second step involved the assessment of inequality using four principal summary measures. These are ratio (R), difference (D), population attributable fraction (PAF) and population attributable risk (PAR). The WHO has stipulated that relative and absolute inequality measures may lead to different and sometimes contrasting conclusions. Therefore, failing to showcase these different scenarios can potentially bias informed decisions, hence the adoption of both absolute and relative summary measures (WHO, 2020). The segment of the equity stratifier with the highest burden of under-five mortality across the four waves was chosen as the reference. For economic status, education, and residence, D was computed by subtracting U5MR among children of poorest women (quintile 1) from the U5MR prevalence among children of richest women (quintile 5), no education group from the secondary/higher education group, and rural minus urban group. The D for the region variable was calculated as the region with the maximum prevalence of U5MR minus the region with the minimum prevalence across the respective survey waves. In computing R, it was calculated as the ratio of two different populations, i.e. $R = Y_{high}/Y_{low}$. In the case of a residence, R denoted a place of residence where Y_{high} stood for urban and Y_{low} stood for the rural population. With education, Y_{high} implied children of women with secondary or higher education where Y_{low} represented children of women with no education. For wealth quintile, Y_{high} was the richest quintile whilst Y_{low} was the poorest quintile. In the same manner, Y_{high} represented males or females, depending on the category with the highest prevalence in a particular survey. PAR was computed as the difference between U5MR estimate for the reference subgroup, yref, and the national average of U5MR. In this study, yref referred to the following to calculate U5MR inequality for PAR: urban setting

Table 1
Trends in under-five mortality rate, disaggregated across five inequality dimensions, 1993–2014.

Dimension	1993 (132.80) N = 7194		1998 (109.92) N = 6290		2003 (109.88) N = 6991		2008 (84.13) N = 5617		2014 (69.92) N = 10,9,37	
	n	R [UI]	n	R [UI]	N	R [UI]	n	R [UI]	n	R [UI]
Economic status										
Q1	1453	156.2 3 [134.48–180.77]	1739	134.98 [117.84–154.18]	1760	128.15 [109.69–149.21]	1412	102.21 [86.53–120.36]	2470	30.91 [78.70–104.80]
Q2	1638	172.90 [153.21–194.53]	1327	120.83 [99.59–145.86]	1581	104.37 [86.45–125.49]	1247	77.87 [63.07–95.78]	2338	73.04 [61.38–86.71]
Q3	1548	138.69 [153.21–194.53]	1231	119.94 [100.35–142.74]	1419	111.84 [92.72–134.33]	1102	102.80 [81.85–128.37]	2229	60.74 [48.47–75.87]
Q4	1355	104.20 [87.39–123.80]	1093	98.85 [79.83–121.81]	1197	108.05 [89.35–130.08]	1031	67.02 [51.11–87.42]	2009	54.98 [43.54–69.20]
Q5	1199	74.96 [60.31–92.81]	899	46.34 [32.95–64.81]	1033	87.64 [67.26–113.43]	825	59.63 [42.42–83.20]	1889	64.00 [49.28–82.73]
Education										
No education	3232	165.68 [148.75–184.12]	2549	131.02 [116.03–147.61]	2952	125.72 [111.76–141.15]	1951	102.15 [88.25–117.95]	3296	91.61 [79.73–105.07]
Primary	3560	108.63 [97.90–120.38]	1288	112.33 [92.23–136.16]	1536	121.13 [103.52–141.26]	1331	86.15 [69.63–106.13]	2206	72.55 [59.26–88.54]
Secondary+	402	69.29 [46.45–102.17]	2452	85.78 [73.54–99.84]	2502	83.48 [70.20–99.02]	2335	67.23 [56.58–79.72]	5435	54.34 [46.24–63.77]
Place of residence										
Rural	5226	149.18 [135.72–163.73]	4707	121.66 [110.40–133.89]	4657	118.64 [107.56–130.70]	3556	89.67 [78.61–102.10]	6099	74.36 [66.41–83.18]
Urban	1968	89.89 [76.41–105.48]	1583	75.74 [62.41–91.63]	2334	92.61 [78.49–108.97]	2061	74.84 [62.41–89.50]	4838	64.23 55.01–74.87]
Sex										
Female	3544	127.94 [115.44–141.57]	3097	106.41 [94.32–119.85]	3402	108.10 [96.35–121.08]	2733	74.95 [64.64–86.75]	5363	62.13 [55.21–69.85]
Male	3650	137.52 [123.51–152.85]	3193	113.33 [101.98–125.76]	3589	111.60 [100.17–124.15]	2884	93.20 [80.94–107.09]	5574	77.40 [69.15–86.54]
Region										
Western	624	131.80 [108.38–159.39]	772	110.04 [87.01–138.26]	678	110.21 [83.50–144.12]	545	63.74 [42.84–93.82]	1102	55.35 [41.14–74.09]
Central	696	128.03 [102.57–158.70]	783	141.64 [108.36–183.04]	580	89.11 [63.88–123.01]	544	108.18 [78.88–146.62]	1194	68.25 [53.34–86.95]
Greater Accra	634	100.20 [73.77–134.73]	672	63.57 [44.60–89.84]	722	73.74 [51.69–104.17]	646	50.83 [33.66–76.08]	1671	47.85 [36.02–63.31]
Volta	762	116.35 [96.90–139.11	658	94.93 [71.52–124.99]	571	113.30 [90.20–141.40]	517	47.48 [28.53–77.98]	869	61.88 [45.90–82.93]
Eastern	788	93.24 [71.14–121.31]	841	89.59 [70.98–112.49]	740	95.90 [73.30–124.54]	498	81.04 [52.97–122.05]	1042	69.00 [54.02–87.73]
Ashanti	1217	97.56 [79.56–119.10]	954	75.90 [58.56–97.84]	1354	116.56 [96.81–139.72]	1072	80.18 [62.22–102.76]	2047	79.09 [61.88–100.58]
Brong Ahafo	728	94.62 [77.11–115.60]	508	129.88 [94.20–176.43]	717	90.73 [70.94–115.35]	501	75.17 [52.82–105.94]	946	57.03 [44.94–72.11]
Northern	929	236.97 [205.54–271.56]	446	170.09 [136.00–210.63]	952	154.76 [126.83–187.51]	816	138.65 [119.11–160.82]	1307	109.06 [86.90–136.06]
Upper West	295	187.71 [133.12–257.99]	205	NR	246	NR	160	NR	450	72.93 [54.69–96.63]
Upper East	520	180.11 [150.96–213.48]	447	154.71 [124.58–190.54]	430	78.97 [51.69–118.82]	314	74.20 [53.85–101.42]	306	90.12 [71.59–112.86]

R, rate; UI, uncertainty interval; NR, not reported – estimate is based on fewer than 250 unweighted person-years of exposure to the risk of death.

for a place of residence, female for sex, secondary education for education and richest subgroups for economic status. With this, (μ): PAR = yref-μ with μ being the national mean of U5MR. Similarly, PAF denoted the relative inequality dimension of PAR, and it was derived as PAF = (PAR/μ)*100. The greater absolute value of PAR indicated a higher level of inequality while zero indicated the absence of inequality. The change in U5MR over time was examined by referring to the 95% uncertainty intervals (UIs) of the different survey years. When the UIs did not overlap, there was a statistically significant difference in U5MR between any two consecutive years. If the UIs overlapped, then no inequality existed.

Ethical issues

We used publicly available data from the DHSs. Ethical procedures were the responsibility of the institutions that commissioned, funded or managed the surveys. All DHS surveys were approved by ICF international as well as an Institutional Review Board in the respective country to ensure that the protocols complied with the U.S. Department of Health and Human Services regulations for the protection of human subjects. In Ghana, ethical approvals for all the rounds of the GDHS are granted by the Ghana Health Service and the Ethical Review Board of the Measure DHS. Both written and verbal consent was obtained from all participants before participating in the surveys, and the data were anonymised before being public.

Results

Table 1 shows the trends in disaggregated U5MR in Ghana spanning from 1993 to 2014. Generally, there was a decline in U5MR from 1993 to 2014. Specifically, U5MR decreased from 109.9 per 1000 live births in 1993 to 69.9 per 1000 live births in 2014. Analysis of U5MR by economic status demonstrated an inverse relationship from 1993 to 2008. Thus, in 1993, U5MR among poor under-fives (172.90, UI = 153.21–194.53) was more than twice the proportion of richest children who died before their 5th birthday (74.96, UI = 60.31–92.81), and this trend continued until 2008. However, in 2014, the poorest had the lowest rate (30.91, UI = 78.70–104.80). Throughout the period, children of women with no formal education recorded the highest rate of under-five mortality. In the case of 1993, 165.68 (UI = 148.75–184.12) U5MR occurred among children of women with no formal education whilst 69.29 (UI = 46.45–102.17) U5MR was observed among children of women with a secondary or higher level of education.

In 2014, 91.61 (UI = 79.73–105.07) and 54.34 (UI = 46.24–63.77) U5MR occurred among children of women having no education and secondary/higher education, respectively. The analysis also revealed that U5MR was higher among rural residents throughout the years. Nonetheless, the variation in 2014 was not wide.

Men persistently had the greatest share of U5MR with the highest prevalence occurring in 1993 (38.22; UI = 35.68–40.82) and the lowest occurring in 2014 (77.40, UI = 69.15–86.54). In terms of regional variations, the Northern region consistently accounted for the greatest proportion of U5MR. In 1993, 1998 and 2003, for instance, Northern region was leading with 236.97 (UI = 205.54–271.56), 170.09 (UI = 136.00–210.63), and 154.76 (UI = 126.83–187.51), respectively (Table 1).

Inequality indices estimates of the factors associated with U5MR prevalence, 1998–2014

We presented the indices of the inequality estimates of factors associated with U5MR in Table 2. Concerning economic status, only the simple summary measures (D, R) showed significant inequality in U5MR. For instance, both D (81.27; 95% CI = 53.10–109.45) and R (2.08; 95% CI 1.54–2.63) revealed substantial economic variation in U5MR, and the same trend was noted across all the survey years (1993–2014). The complex summary measures (PAF and PAR)

Table 2
Inequality indices estimates of the factors associated with under-five mortality rate, 1993–2014.

Dimension	1993			1998			2003			2008			2014		
	Est	LB	UB	Est	LB	UB	Est	LB	UB	Est	LB	UB	Est	LB	UB
Economic status															
D	81.27	53.10	109.45	88.65	64.69	112.61	40.52	1031	70.72	42.59	16.37	68.80	2.91	5–0.85	47.97
PAF	−43.60	−45.13	−42.07	−57.91	−60.67	−55.15	−20.35	−21.85	−18.86	−29.19	−32.82	−25.56	−8.16	−10.97	−5.36
PAR	−57.94	−59.98	−55.91	−63.76	−66.79	−60.72	−22.40	−24.04	−20.75	−24.58	−27.64	−21.53	−5.69	−7.64	−3.73
R	2.08	1.54	2.63	2.91	1.85	3.97	1.46	1.02	1.91	1.71	1.07	2.36	1.42	1.00	1.84
Education															
D	96.36	63.85	128.92	45.23	24.74	65.73	42.24	21.73	62.75	34.92	16.17	53.67	37.27	21.92	52.62
PAF	−47.53	−50.79	−44.27	−21.70	−22.24	−21.16	−23.83	−24.55	−23.10	−19.81	−21.41	−18.2	−21.52	−22.85	−20.20
PAR	−62.77	−67.07	−58.46	−23.77	−24.36	−23.18	−26.11	−26.90	−25.32	−16.61	−17.95	−15.27	−14.91	−15.83	−13.98
R	2.39	1.41	3.37	1.53	1.23	1.82	1.51	1.19	1.82	−1.52	1.18	1.86	1.69	1.33	2.04
Place of residence															
D	59.29	39.16	79.42	45.92	27.25	64.59	26.04	6.96	45.11	14.83	−3.02	32.68	10.13	−2.82	23.08
PAF	−32.39	−32.56	−32.23	−31.21	−32.68	−29.75	−15.77	−16.01	−15.54	−11.15	−12.80	−9.49	−8.09	−9.49	−6.68
PAR	−43.07	−43.29	−42.85	−34.37	−35.98	−32.76	−17.34	−17.60	−17.08	−9.39	−10.78	−8.00	−5.65	−6.63	−4.67
R	1.66	1.35	1.97	1.61	1.26	1.95	1.28	1.04	1.53	1.20	0.93	1.46	1.16	0.94	1.38
Sex															
D	9.59	−10.02	29.20	6.92	−10.48	24.32	3.50	−13.69	20.68	18.25	1.19	35.31	15.27	3.93	26.61
PAF	−3.66	–	–	−3.19	–	–	−1.63	–	–	−11.11	−12.34	−9.898	−11.13	−12.41	−9.85
PAR	−4.86	–	–	−3.51	–	–	−1.80	–	–	−9.37	−10.41	−8.34	−7.78	−8.68	−6.89
R	1.07	0.92	1.23	1.07	0.90	1.23	1.03	0.87	1.19	1.24	0.99	1.50	1.25	1.04	1.45
Region															
D	143.73	102.41	185.05	–	–	–	–	–	–	–	–	–	61.21	33.30	89.11
PAF	−29.68	−30.59	−28.77	–	–	–	–	–	–	–	–	–	−31.78	−34.93	−28.63
PAR	−39.36	−40.56	−38.15	–	–	–	–	–	–	–	–	–	−22.29	−24.50	−20.08
R	2.54	1.78	3.31	–	–	–	–	–	–	–	–	–	2.28	1.46	3.10

D, difference; Est, estimate; LB, lower bound; PAF, population attributable fraction; PAR, population attributable risk (PAR); R, ratio; UB, upper bound.

however showed significant but negative association throughout the survey waves. In terms of educational level, we found significant absolute and relative inequality across the survey waves. For example, in 1993, there was a significant absolute inequality (D = 96.36, 95% CI; 63.85, 128.92) and relative (R = 2.39, 95% CI; 1.41, 3.37) in U5MR. This pattern showed a decreasing trend in both the simple measures (D, R), as well as the complex measures (PAR, PAF). The study also found absolute and relative urban-rural inequality in U5MR from 1993 to 2014 both by simple (D, R) and complex (PAR, PAF) measures with a decreasing pattern. For example, in 1993, the D measure was 59.29 (39.16, 79.42) and R measure (R = 1.66, 95% CI; 1.35, 1.97) which all reduced to D = 10.13(-2.82, 23.08) and R = 1.16, CI = 0.94, 1.38, respectively. Our finding also shows absolute (D, PAR) and relative (R, PAF) inequality in U5MR across the regions in Ghana. For example, in 2014 survey, the PAR measure (PAR = −22.29, 95% CI; −24.50, −20.08) and the PAF measure (PAF = −31.78, 95% CI; −34.93, −28.63) indicate substantial absolute and relative regional inequality, respectively (Table 2).

Discussion

From the study, we observed a decline in U5MR from 1993 to 2014. Specifically, U5MR decreased from 109.9 per 1000 live births in 1993 to 69.9 per 1000 live births in 2014. Even though the 50% reduction over the 21 years is commendable, it still falls short of the global target of at most 25 per 1000 live births.[3] Ghana has introduced several programs and health interventions over the years to address specific public health issues including under-five mortality. Examples of such programs targeted at addressing U5MR include free maternal health care, national health insurance with free insurance cover for children, community health planning services, and the utilization of community health nurses for the door-to-door immunization exercises, which have largely been reported as successful.[16] These interventions and programs could plausibly be the reasons behind the significant decline in the U5MR from 109.9 per 1000 live births in 1993 to 69.9 per 1000 live births in 2014.

Findings from the study showed an inverse relationship between economic status and U5MR from 1993 to 2008 where children under-five from poorest households were more likely to die, as compared with under-five children born in richer households. However, the trend changed in 2014 where the poorest now had the lowest U5MR. The trend from 1993 to 2008 is consistent with the findings from previous studies in Ethiopia,[5,17,18] Kenya,[19] Nigeria[20] and Sierra Leone.[10] Even though primary health care in Ghana is free for children younger than 5 years of age, there are still some opportunistic costs and expenses that parents and caregivers incur when they seek quality health care for their under-five children. The costs become unbearable for poorer households especially when there are persistent health problems.[17] Poorer households often have challenges with good and balanced nutrition, hygiene, and safe shelter both for the children and their mothers, which could impact on the survival of under-five children.[7,21,22] The switch in the trend in 2014 could be as a result of a larger coverage of maternal and child health programs accelerated by the Ministry of Health after the 2008 DHS in a race to achieve the 2015 Millennium Development Goals. For example, policies and programs such as the free maternal health care were introduced during that same period, traditional birth attendants were also given training, and their activities were monitored by the Ghana Health Service. The National Health Insurance Scheme and immunization programs were also revised and expanded within that same period.[23] A further study is needed to investigate the reason behind the switch in 2014 to inform existing and future policies and interventions towards achieving the 2030 SDG 3.

The literature reveals education as a good predictor of health outcomes. In support with the findings from previous studies,[17,18,24,25] our study observed that mothers with no formal education recorded the highest U5MR and this persisted throughout the 21 years under observation. The plausible reason could be that educated mothers have greater control over health choices for their children and the ability to use basic health knowledge to manipulate their environment and healthcare providers, and communicate more effectively with health professionals.[25] This re-emphasize the importance of girl child education in Ghana and the need for all stakeholders to accelerate efforts ensuring that all girls of school-going age have the opportunity to be in school. Aheto[1] has further explained that 'educated mothers are more likely to develop good health-seeking behaviour for themselves and their children, especially the utilization of health services, feeding and child care practices which in turn will result in better health outcomes for both mothers and their children'.

Another important trend observed in our study is that absolute and relative urban-rural inequality in U5MR existed throughout the years from 1993 to 2014. U5MR was high among rural residents while urban areas recorded low U5MR. This is consistent with a study in SSA that found high U5MR in rural areas in Comoros, Lesotho, Namibia, Niger, and Senegal.[2] However, from this same study by Malderen et al.,[2] U5MR was reported to be low in rural areas in Congo, Kenya and Tanzania. The rural-urban disparities in U5MR could be because of disparities in health systems, economy and socio-political factors at each study area.[26] Urban dwellers in most LMICs have improved financial and geographic access to health care Malderen et al.,[2] as quality healthcare services and facilities are often skewed towards urban settlements. This could explain why U5MR in Ghana over the past 21 years has been low in urban areas compared with rural areas.

We also observed that the sex of children was significant in influencing under-five mortality in Ghana. Men persistently had the greatest share of U5MR from 1993 to 2014. This finding is not novel, as similar findings have been found in Ethiopia,[17] Ghana[1] and many other sub-Saharan African countries such as Benin, Chad, Congo, Côte d'Ivoire, Gabon, Malawi, Mozambique, Rwanda, Sierra Leone, Uganda and Zambia.[2,27] Disparities in child survival rates based on their sex have been well established in the literature globally, especially for children younger than five years.[28] Even though some scientists have attributed this finding to biological factors such as male children or babies having lower resistance to infection, increased risk of premature birth, larger average body size and head circumference making it difficult for mothers during delivery, others have also mentioned the importance of some socio-cultural factors which could lead to gender discrimination and sex selection or preference.[29] Future studies could explore why more males under five years die compared to their female counterpart in Ghana, taking into consideration the Ghanaian socio-cultural factors.

In support with previous studies in Ethiopia,[17] Nigeria[30,31] and Ghana,[1,21] our finding also shows absolute (D, PAR) and relative (R, PAF) inequality in U5MR across the regions in Ghana, with the Northern region, which is also predominantly rural, consistently accounting for the greatest proportion of U5MR. Ghana is characterized by persistent regional disparities in the distribution of quality healthcare services, economic resources,[1] and the implementation of national health programs.[23] This could explain the regional variations in U5MR in Ghana and offer plausible ideas on how this disparity could be addressed.

Limitations of the study

Causal inferences cannot be made from this study because of the use of the cross-sectional study design. Furthermore, this study did not use the first version of the GDHS because some of the variables in that survey were not consistent with those used in the subsequent surveys (i.e. 1994 to 2014). The 2014 version is the most recent and though this appears to be quite obsolete, it is important to know that the observations made with the 1993 to 2014 data sets are crucial in providing policy makers with some ideas on which socio-economic groups of the Ghanaian population that must be targeted to reduce under-five mortality to an acceptable level. Despite these limitations, this study provides a nationally representative coverage of under-five mortality in Ghana, and the findings from the study can be generalized for all children younger than five years in Ghana.

Conclusion

Ghana has experienced a decline in under-five mortality from 1993 to 2014. However, are socio-economic and geographical disparities, with a high prevalence of under-five mortality among children in poor households, those born to mothers with low educational level, those in rural areas and children born in Northern regions. Although inequalities varied throughout the years studied, context-specific appropriate interventions are necessary for various disadvantaged sub-populations who continue to suffer from disparities in U5MR.

Author statements

Ethical approval

We used publicly available data from the Demographic and Health Surveys (DHSs). Ethical procedures were the responsibility of the institutions that commissioned, funded or managed the surveys. In Ghana, ethical approvals for all the rounds of the DHS are granted by the Ghana Health Service and the Ethical Review Board of the Measure DHS Both written and verbal consent was obtained from all participants before participating in the surveys, and the data were anonymised before being public. Therefore, the authors are not required to seek ethical approval.

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Competing interest

None declared.

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