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A longitudinal study of piece rate and health: evidence and implications for workers in the US gig economy

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ABSTRACT

Objectives: The objective of this study was to evaluate health outcomes for workers subject to piece rate historically to better understand the implications of pay type in the modern-day gig economy. While piece rate occurring in the 1980s and 1990s predates recent platform-based employment, it introduced and normalized patterns of economic precariousness that are instrumental in the current gig economy. Evidence suggests that such pay types may result in poor health outcomes; however, cross-sector evidence of its long-term effects on US workers is lacking. This article represents the first longitudinal cross-sector analysis relating health outcomes to this performance pay type in US workers.

Study design: This is a longitudinal cohort study.

Methods: Data from six survey waves of the 1979 National Longitudinal Survey of Youth collected between 1988 and 2000 are used in a random-effects logit model to predict self-reported health limitations related to piece rate, while controlling for worker, work environment, lifestyle, time, and location trends.

Results: Pay tied to piece rate in current or prior periods significantly increases the odds of self-reported health limitations compared with salaried work (odds ratio [OR]: 1.4–1.8). These effects are elevated for the subgroups of low-wage (OR: 1.5–1.8), female (OR: 1.8–1.9), and non-white (OR: 2.0–2.1) workers compared with their high-wage, male, and white peers.

Conclusions: The results suggest that piece rate pay designed to promote efficiency may have important negative implications for worker health, especially for the most vulnerable members of the US workforce such as women, minority, and low-income workers. Given the growing popularity of performance-based pay to the gig economy, more research is needed to determine if the practice is justified from a public health perspective.

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Introduction

Adam Smith surmised at the start of the industrial revolution in *Wealth of Nations* (1776) that ‘Workmen...when they are liberally paid by the piece, are very apt to overwork themselves, and to ruin their health and constitution in a few years’.¹ The practice of tying worker compensation directly to effort represents the dominant form of pay in the growing ‘gig economy.’ Gig work is best described as the division of paid effort into smaller components, offered to independent contractors with low barriers to entry via a Web-based platform.²

This article explores the historical form of pay type most closely aligned with modern-day gig work – piece rate – to understand the potential impact of recent transitions in performance-based pay on worker health. ‘Piece rate’ links pay directly to the quantity of goods or services a worker produces. Despite recent declines in US manufacturing where piece rate was particularly popular,³ it continues to be prevalent in certain sectors such as the booming logistics industry, where temporary workers and truck drivers are paid by the truckload. Piece rate pay in this industry has been associated with risky behavior, leading to increased accidents and fatalities for workers and bystanders and spurring demands for changes to the incentive structure for workers in this industry.⁴

While our analysis focuses on piece rate through the 1980s and 1990s, which predates recent platform-based gig employment, the expansion of contingent labor practices such as piece rate in these formative pre-gig years remains relevant to the current gig economy.⁵ With this historical perspective in mind, we evaluate health outcomes for workers subject to piece rate compensation in a longitudinal panel to provide context for understanding the implications of modern-day performance-based pay in the growing gig economy.

Methods

We test the relationship between exposure to piece rate and self-reported worker health outcomes using data from a cohort of US workers maintained by the Bureau of Labor Statistics – the National Longitudinal Survey of Youth 1979 (NLSY79). The NLSY79 is a large cohort study of US workers born between 1957 and 1964, with follow-up available initially on an annual basis from 1979 to 1994 and then biannually from 1994 through 2014. However, data on piece rate pay are limited to six of those survey waves (1988, 1989, 1990, 1996, 1998, and 2000). Although these data are more limited than the full NLSY panel, they provide a unique series of repeated observations on individual workers, which allows us to follow workers as they move in and out of piece rate jobs and identify cumulative health effects that may exacerbate over time.

Table 1 summarizes the data available during the six survey waves of the NLSY79 with pay type information. ‘Piece rate’ is a category of performance-based pay that is directly tied to the unit of production or service, which is analogous to how the gig economy typically compensates contract workers for direct effort. Exposure to piece rate pay represents on

average nearly 3% of the total jobs reported by workers over the sample period. However, roughly 10% of the surveyed workers reported at least one piece rate job during the entirety of the observed period, which is similar to previously cited estimates of the prevalence of piece rate pay in US workers over this time period⁶ as well as the number of US workers primarily doing independent work.⁷

The data describing worker health outcomes in the NLSY79 vary depending on the survey year, as the health section of the questionnaire was adapted over time to reflect respondents’ varying life cycle stages. The most complete match to the six survey waves of pay type data is represented by the variable ‘Health limitation.’ For this variable, workers self-report whether they have any health condition or circumstance that limits their activities, work, or otherwise. Similar to all variables in the NLSY data series, Health limitation is subject to self-reporting bias. Given the data available, there is no way to determine the extent to which this may be impacting the associations reported in this article. However, unless workers reporting piece rate are differentially biased than their salaried peers in how they report health limitations, any self-reporting bias should not impact that primary covariate of interest.

Other important control variables identified in Table 1 include key worker demographics such as income, race, education, sex, age, and health insurance status. The low-wage cutoff is based on the definition of the US Department of Health and Human Services as a nominal hourly wage below 145% of the federal minimum poverty wage. Additional work-related covariates are noted for workers in the manufacturing sector where piece rate is more common, self-employed, tenure at job, and hours worked per week, as evidence suggests that workers paid through incentive-based systems tend to work more hours per week than salaried workers.⁸

Finally, important personal health behaviors such as diet, exercise, and smoking are only available for a single survey wave but included in the model as time-invariant controls. These individual worker habits provide important information on health status and risk preferences, which impact the unobserved sorting of workers into various workplaces. Smoking status has been used in previous research as an indicator of risk preference based on evidence that US workers who smoke take substantially more risky jobs in terms of occupational safety, earnings, and employment.⁶ Given the limitations of the time-invariant data series, there is no way to determine the extent to which changing health behaviors and attitudes toward health are impacting the associations observed in this study. However, any changes in health behaviors are unlikely to impact the primary variable of interest, piece rate, unless these behaviors and attitudes change differentially over time for workers receiving piece rate vs salary.

A total of 8,985 individuals initially reported data on piece rate (yes/no) during the first survey wave (1988), which represents the overall potential base sample of workers in this study. However, some workers stopped reporting data as time progressed, starting with 0.5% of the sample in the first follow-up period (1989) and progressing to 11.3% of the initial sample by the last survey wave (2000). Intermittently missing values for the other variables also contributed to a reduction

Table 1 – Summary statistics for NLSY79 survey waves 1998, 1989, 1990, 1996, 1998, and 2000.

Variables	Definition	Categories	N	Mean	S.D.	Min	Max	% missing (n = 53,910)
Primary dependent variable								
Health limitation	Worker reports health limitation(s)	0 = No, 1 = Yes	48,775	0.07	0.25	0	1	9.5%
Primary independent variables								
Annual piece rate	Primary job reported as piece rate in the current survey wave	0 = No, 1 = Yes	38,702	0.03	0.17	0	1	28.2%
Ever piece rate	Any job (not just primary) reported as piece rate in the current or previous survey wave	0 = No, 1 = Yes	39,902	0.10	0.30	0	1	26.0%
Additional covariates								
Hours worked per week	Hours per week in primary job	Continuous	44,501	40.17	11.93	0	168	17.5%
Male	Worker is male	0 = No, 1 = Yes	53,910	0.50	0.50	0	1	0%
Manufacturing	Has any job in the manufacturing industry	0 = No, 1 = Yes	44,453	0.20	0.40	0	1	17.5%
Low-wage worker	Wage <145% of fed. minimum	0 = No, 1 = Yes	43,273	0.63	0.48	0	1	19.7%
Education	Highest grade completed	Count	49,142	12.93	2.41	0	20	8.8%
Non-white	Individual is black or Hispanic	0 = No, 1 = Yes	53,910	0.49	0.50	0	1	0%
Tenure at primary job	Years of tenure at primary job	Continuous	42,738	4.20	4.62	0	31	20.7%
Health insurance	Covered by health insurance plan	0 = No, 1 = Yes	40,789	0.81	0.39	0	1	24.3%
Age (years)	Age at interview	Continuous	53,910	32.20	5.12	23	44	0%
Self-employed	Self-employed in any job	0 = No, 1 = Yes	44,435	0.10	0.30	0	1	17.6%
Cross-sectional variables^a								
Diet	Trying to lose weight (self-reported 2002)	0 = No, 1 = Yes	43,866	0.44	0.50	0	1	18.6%
Exercise	Engages in exercise at least three days per week (self-reported 2002)	0 = No, 1 = Yes	41,448	0.64	0.47	0	1	23.1%
Smoker	Currently smokes at least one cigarette per day (self-reported 1998)	0 = No, 1 = Yes	45,234	0.32	0.47	0	1	16.1%

NLSY79, National Longitudinal Survey of Youth 1979; S.D., standard deviation.

^a Variables only available as cross sections reported in a single survey wave; observations repeated through the longitudinal panel to identify time-invariant impact of important health-related behaviors.

in the overall sample size available for analysis as noted in [Table 1](#).

Sensitivity analyses compared the health of workers missing piece rate information with those reporting it, conducted separately by survey wave to control for the deleterious effect of increasing age on health. Workers missing piece rate data report comparatively poorer health than workers who respond (yes/no) with this information. These results indicate that a healthy worker effect might be prompting selection (sorting) bias in the cohort. However, this healthy worker effect, if present, is likely to bias the analytical results on piece rate toward the null, attenuating the estimated odds ratios (ORs) in favor of no significant effect.

A final note on missing data in the sample is that health insurance is not reported at all in one of the six survey waves and including it as a covariate would limit the time points observed to five survey waves. However, health insurance may have a significant impact on worker health outcomes and represent a confounder if workers paid by piece rate experience differential rates of coverage compared with their salaried peers. For this reason, results from the more complete panel of data are presented in the body of this article, while the analyses that include health insurance as an explanatory variable are reported for comparison purposes as an [Appendix](#).

Statistical model

A random-effects logit model was used to predict the presence of self-reported worker health limitations using the `xlogit` command in STATA, version 15, (College Station, TX) based on the following Equation (1):

$$I_{it} = \alpha_0 + \beta X_{it} + \delta W_{it} + \phi \text{PayType} + \sigma_i + \pi_k + \kappa_t + \varepsilon_{it} \quad (1)$$

Where *i* and *t* indicate index workers and survey waves, respectively, and *I* is the presence of a health limitation (0 = No, 1 = Yes). Descriptive statistics of the variables used to identify Equation (1) are provided in [Table 1](#). *X* and *W* control for heterogeneity across workers and work environments, respectively. σ , π , and κ control for worker, region (determined by Census division), and survey wave effects, respectively. Worker-level random-effects control for unobserved characteristics such as risk preferences that might impact the sorting of workers into piece rate jobs, and errors are clustered by worker to control for repeated observations within the panel series. An advantage of the random-effects model in this case is that it allows us to control for time-invariant demographic characteristics directly, providing an estimate of their effects on the dependent variable.

Pay type is defined in two ways: as an annual value of piece rate reported in a worker's primary job (0 = No, 1 = Yes) and as a cumulative piece rate specification that takes on a value of 1 if a worker has reported piece rate at any point before or during the observed survey wave. While the annual piece rate is intended to capture the immediate health consequences of this pay type, the cumulative piece rate variable may capture the ongoing and exacerbating impact of piece rate pay over time. Alternative specifications of cumulative and lagged piece rate linking one period directly to the period before and

after were not appropriate because of the time discontinuity of the six survey waves. The final data set does not contain survey weights, which are inappropriate for longitudinal analyses of the NLSY79 cohort.⁹

The logit model described previously was adapted and run separately for specific subgroups of vulnerable workers, focusing on low-income (vs high-income), female (vs male), and non-white (vs white) workers, to explicitly identify whether the modeled relationships were significantly different for susceptible subgroups of workers. Alternative specifications using interaction terms to explore differential effects across subgroups were also tested. Only the results of the separate subgroup analyses are reported here, as this approach allowed us test for both differential and individual effects of piece rate on health across the various subgroups of workers.

Results

[Tables 2 and 3](#) provide estimates of the effect of piece rate on worker health limitations for this cohort. [Table 2](#) relates annual piece rate to health limitations in a specific survey wave, while [Table 3](#) presents similar results, specifying the piece rate impact as cumulative over time. All coefficients are represented as ORs to facilitate interpretation and comparisons of the effects. Being paid piece rate compared with salaried work has a statistically significant negative effect on worker health both in the annual (OR = 1.75) and cumulative (OR = 1.42) specifications, suggesting both immediate and longer term impacts on worker health. When broken down by subgroup, the odds of reporting health limitations fall away for high-income, male, and white workers but are amplified and remain statistically significant for the subgroups of low-wage (OR = 1.53–1.77), female (OR = 1.80–1.94), and non-white (OR = 1.95–2.05) workers. Additional covariates statistically and significantly related to health limitations include age, tenure at job, hours worked, self-employment, and education, as well as the time-invariant health behaviors including exercise, dieting, and smoking. Although the size of the effects varied across specifications, the odds that a worker reported health limitations generally increased with age, smoking status, and dieting, while tenure on the job, hours worked, education, and exercise were all associated with reduced worker health limitations.

Health insurance as an independent variable reduces the sample size available for the analysis by one survey wave, limiting the number of follow-up periods and the power of the study to detect statistically significant differences; however, because health insurance plays a potentially important role in a worker's health, separate specifications including this variable are presented as an [Appendix \(Tables A-1 and A-2\)](#). Similar to the primary specifications that include data from all available survey waves, currently receiving piece rate pay is associated with a significantly increased odds of reporting a health limitation, overall and specifically for the subpopulations of low-wage, female, and non-whites workers (OR = 1.8–2.1). The coefficient is similar for workers ever receiving piece rate (OR = 1.4) but is no longer statistically

Table 2 – Effect of piece rate on the odds of worker health limitations.

Variable	Full model	Not low wage	Low wage	Male	Female	White	Non-white
Piece rate (annual)	1.75** (1.16–2.62)	2.05 (0.74–5.66)	1.77* (1.14–2.74)	1.58 (0.82–3.05)	1.94* (1.15–3.26)	1.50 (0.87–2.59)	1.95* (1.09–3.50)
Age	1.06** (1.01–1.11)	1.05 (0.94–1.16)	1.08** (1.03–1.14)	1.11** (1.03–1.20)	1.03 (0.98–1.09)	1.10** (1.03–1.18)	1.03 (0.97–1.09)
Manufacturing job	0.90 (0.72–1.14)	0.69 (0.40–1.20)	1.00 (0.78–1.28)	0.84 (0.60–1.18)	0.93 (0.69–1.27)	0.91 (0.66–1.25)	0.92 (0.67–1.27)
Tenure at primary job	0.96** (0.94–0.98)	0.99 (0.95–1.03)	0.96** (0.93–0.98)	0.98 (0.95–1.01)	0.95** (0.92–0.98)	0.94** (0.91–0.96)	1.00 (0.97–1.03)
Hours worked per week	0.99** (0.98–0.99)	0.97** (0.95–0.98)	0.99 (0.98–1.00)	0.98** (0.96–0.99)	0.99 (0.98–1.01)	0.99** (0.97–0.99)	0.99 (0.97–1.00)
Self-employed	1.33 (0.98–1.80)	1.25 (0.64–2.41)	1.36 (0.96–1.92)	1.20 (0.76–1.89)	1.46 (0.97–2.19)	1.42 (0.96–2.11)	1.26 (0.78–2.03)
Education	0.89** (0.85–0.94)	0.98 (0.88–1.08)	0.89** (0.84–0.94)	0.90** (0.84–0.97)	0.89** (0.83–0.95)	0.88** (0.82–0.95)	0.90** (0.84–0.96)
Non-white	0.85 (0.68–1.05)	0.96 (0.59–1.56)	0.81 (0.64–1.03)	0.81 (0.57–1.16)	0.86 (0.65–1.12)	N/A	N/A
Male	0.72** (0.57–0.91)	0.63 (0.37–1.08)	0.77* (0.60–0.99)	N/A	N/A	0.75 (0.53–1.07)	0.70* (0.51–0.97)
Low wage	1.59** (1.27–1.98)	N/A	N/A	2.00** (1.45–2.76)	1.30 (0.96–1.75)	1.51** (1.12–2.04)	1.69** (1.22–2.34)
Exercise (2002)	0.54** (0.44–0.67)	0.52* (0.31–0.86)	0.55** (0.44–0.69)	0.36** (0.26–0.52)	0.72* (0.55–0.94)	0.47** (0.34–0.64)	0.64** (0.48–0.86)
Diet (2002)	1.40** (1.13–1.73)	1.34 (0.84–2.16)	1.40** (1.11–1.77)	1.31 (0.92–1.88)	1.42* (1.08–1.85)	1.60** (1.17–2.18)	1.20 (0.89–1.61)
Smoker (1998)	1.65** (1.32–2.07)	2.41** (1.39–4.19)	1.55** (1.23–1.97)	1.55* (1.09–2.22)	1.69** (1.27–2.25)	1.95** (1.40–2.70)	1.34 (0.99–1.82)
N (observations)	26,655	9,647	17,008	13,064	13,591	14,036	12,619
N (individuals)	6,145	3,229	5,036	2,912	3,233	3,205	2,940

Odds ratios reported, 95% confidence interval in parentheses; model controls for survey year and census division (results not reported); ** $P < 0.01$, * $P < 0.05$.

significant, while it remains statistically significant for the vulnerable subsets of workers (OR = 1.5–2.1).

Discussion

The evidence presented in this study suggests that piece rate pay, which is increasingly popular as a compensation mechanism for contract workers in the gig economy, increases the odds of health limitations compared with salaried work. Interestingly, the deleterious effects of this type of performance-based pay are not borne uniformly across workers and instead appear to disproportionately impact low-wage, female, and non-white workers compared with higher wage, male, and white peers. This study is the first one to attempt a large-scale longitudinal and cross-sector analysis of US workers, linking health outcomes to piece rate. It builds on previous efforts to use the NLSY1979 cohort to identify a statistically significant impact of pay type on worker accident and injury risk.⁶ Similar international studies identified a statistically significant relationship between piece rate and worker health across sectors in the UK;^{8,22} however, these results may have limited applicability in the US context because of differences in underlying worker protection and labor laws. The present study corroborates the UK findings for US workers, with poorer health outcomes reported for piece rate workers than for salaried workers, especially for the low-wage, female, and minority workforce.

The elevated risk to vulnerable worker groups is not surprising, as previous literature linked piece rate pay to increased risk of occupational accidents and injuries for blue-collar workers⁶ and women.¹⁰ There is also mounting evidence that racial and gender bias in performance reviews reinforces gender and racial pay gaps.¹¹ If women and racial minorities must work harder than their male and white peers to attain the same level of pay, then they could be reasonably expected to face a greater physical and emotional toll within the context of piece rate and gig pay. Recent evidence specific to the gig economy finds growing inequality among the bottom 80% of the distribution of workers in these jobs,² as well as a gender gap in earnings favoring men.⁷ More research is needed to understand these differential effects, which could be the result of many factors beyond wage incentives, including but not limited to current and historical discrimination practices in hiring and employment.

Key evidence has surfaced since Adam Smith's early conjecture to support his theory of the negative health impacts of tying worker compensation directly to their productivity output. Studies have linked incentivized pay schemes to increased accident and injury risk,^{6,8,10,12,13} as well as poor health outcomes in specific populations or industries. For example, negative effects of pay by the piece have been observed on the body mass index in Filipino farmers,¹⁴ absenteeism in German steel plant workers,¹⁵ depression and somatic complaints in Israeli garment workers,¹⁶ elevated heart rates in Canadian loggers,¹⁷ and medication usage in

Table 3 – Cumulative effect of piece rate on the odds of worker health limitations.

Variable	Full model	Not low wage	Low wage	Male	Female	White	Non-white
Piece rate (ever)	1.42* (1.03–1.96)	0.83 (0.36–1.90)	1.53* (1.09–2.15)	1.14 (0.70–1.87)	1.80** (1.16–2.78)	0.88 (0.53–1.47)	2.05** (1.36–3.11)
Age	1.06** (1.02–1.11)	1.05 (0.95–1.17)	1.08** (1.03–1.13)	1.11** (1.03–1.19)	1.03 (0.98–1.09)	1.10** (1.03–1.18)	1.03 (0.96–1.09)
Manufacturing job	0.91 (0.73–1.14)	0.69 (0.39–1.20)	1.01 (0.79–1.29)	0.81 (0.58–1.14)	0.96 (0.71–1.31)	0.93 (0.67–1.28)	0.92 (0.67–1.27)
Tenure at primary job	0.96** (0.94–0.98)	0.99 (0.95–1.03)	0.96** (0.93–0.98)	0.97 (0.94–1.01)	0.95** (0.92–0.98)	0.93** (0.90–0.96)	1.00 (0.96–1.03)
Hours worked per week	0.98** (0.98–0.99)	0.96** (0.95–0.98)	0.99* (0.98–0.99)	0.97** (0.96–0.98)	0.99 (0.98–1.00)	0.98** (0.97–0.99)	0.99 (0.97–1.00)
Self-employed	1.36* (1.03–1.80)	1.25 (0.66–2.36)	1.41* (1.03–1.93)	1.29 (0.86–1.96)	1.42 (0.98–2.08)	1.41 (0.98–2.05)	1.32 (0.86–2.04)
Education	0.89** (0.85–0.94)	0.96 (0.87–1.06)	0.89** (0.84–0.94)	0.90** (0.83–0.96)	0.89** (0.83–0.94)	0.87** (0.81–0.94)	0.90** (0.84–0.96)
Non-white	0.83 (0.67–1.03)	0.98 (0.60–1.59)	0.78* (0.62–0.99)	0.79 (0.56–1.13)	0.84 (0.64–1.10)	N/A	N/A
Male	0.72** (0.57–0.91)	0.67 (0.39–1.14)	0.76* (0.59–0.99)	N/A	N/A	0.78 (0.55–1.10)	0.67* (0.49–0.93)
Low wage	1.61** (1.29–2.00)	N/A	N/A	1.96** (1.44–2.69)	1.35 (1.00–1.82)	1.61** (1.19–2.17)	1.62** (1.18–2.24)
Exercise (2002)	0.54** (0.44–0.68)	0.49** (0.30–0.82)	0.54** (0.44–0.70)	0.37** (0.26–0.52)	0.72* (0.55–0.94)	0.47** (0.34–0.64)	0.64** (0.48–0.86)
Diet (2002)	1.39** (1.12–1.72)	1.33 (0.83–2.14)	1.39** (1.10–1.75)	1.36 (0.96–1.93)	1.39* (1.07–1.82)	1.62** (1.19–2.21)	1.16 (0.78–1.56)
Smoker (1998)	1.64** (1.32–2.05)	2.29** (1.32–3.97)	1.54** (1.22–1.95)	1.59** (1.12–2.25)	1.64** (1.23–2.18)	1.84** (1.33–2.55)	1.41* (1.04–1.91)
N (observations)	27,158	9,818	17,340	13,392	13,766	14,343	12,815
N (individuals)	6,156	3,257	5,077	2,915	3,241	3,212	2,944

Odds ratios reported, 95% confidence interval in parentheses; model controls for survey year and census division (results not reported); **P < 0.01, *P < 0.05.

Canadian garment workers.¹⁸ Pay for performance has also been linked to increased worker compensation costs in a US shoe-manufacturing firm,¹⁹ negative physical and emotional health outcomes in Vietnamese garment workers,²⁰ and negative self-reported health outcomes, back problems, and repetitive stress injuries in cross-industry analyses of British workers.^{21,22} Additional evidence linking poor health and well-being outcomes specifically to modern-day gig work is limited but growing.²

Although incentivized pay systems are generally understood to increase worker productivity,^{23–26} the impact on overall profits for business operations that pay workers in this way remains a topic of debate.^{19,27} Evidence suggests that gains in productivity may be offset by maladaptive worker behaviors, including those detrimental to health that ultimately increase operating costs and lower business profits.^{6,19,28} This unintended consequence makes intuitive sense, as worker behaviors and activities that are financially rewarded, such as increased output, take precedence over those that are not rewarded, in this case worker health and safety. This study extends the argument one step further to suggest that poor health outcomes linked to performance and piece rate might further erode a company's bottom line, as health limitations are likely to result in increased health-related absenteeism, lower performance, and higher healthcare costs. Indeed, higher health costs related to performance-based pay might explain why labor platform companies such as Uber are so strongly resisting having legal status as employers. The externalization of health and other traditional fringe expenses onto their gig

workforce may be a pivotal pillar of their business model. The negative effect of piece rate pay may be particularly harmful to the profits of companies staffed with the vulnerable worker groups highlighted in the current analysis.

Limitations

While the NLSY79 provides a large and representative sample of US workers over time, the data available on piece rate are limited to six years of follow-up and are missing for some surveyed workers. In addition, key health behavior variables are available only in a single survey wave, and the NLSY data are subject to self-report error. However, as noted previously, these sources of bias are most likely to attenuate the relationship between piece rate and health in the direction of the null hypothesis.

The longitudinal study design with random effects as well as the inclusion of worker risk preferences such as smoking status are intended to control for unobserved characteristics that might impact the sorting of workers into workplaces; however, failure to fully account for non-random sorting will bias the estimated effects. This bias would again be trended toward the null, assuming more able-bodied workers sort into potentially higher paying piece rate work as noted in previous analyses.²⁹

Although these data were not sufficiently robust to identify causal effects of piece rate pay on health, the analyses highlighted statistically significant associations between piece rate pay and worker health limitations, most notably among the susceptible subgroup categories.

Conclusion

This study is the first to explore the effects of piece rate on worker health outcomes in a large and representative longitudinal panel of US workers across sectors. The results suggest that a worker's health suffers as a result of piece rate compared with salaried work, especially for vulnerable subgroups of the US workforce. In fact, the results show little to no impact of piece rate for the non-susceptible segments of the working population, with the entirety of the effect borne by low-income, female, and non-white workers. Further research is needed to understand why these workers suffer worse health outcomes than their more advantaged peers and to identify the underlying reasons why piece rate increases health problems in already vulnerable worker groups.

The results of this research provide suggestive evidence of increased healthcare costs for workers subject to piece rate by way of declining health. Although performance pay schemes are generally understood to be revenue promoting, the impact on profits that include costs related to worker health, declining performance, and absenteeism deserve further review. Incentive-based pay schemes such as piece rate should be evaluated in terms of their health-limiting effects on the workforce and not just by increased efficiency measures. Further research is needed to determine best practices around piece rate and profits, as this type of performance pay may represent a lose-lose scenario for both workers and businesses.

Future research efforts should also be guided toward directly testing the pay-health relationships observed in this historical analysis of long-term trends on modern-day gig and contract workers. Analysis of data on modern-day gig and piece rate contract workers would reveal differences in trends critical to understanding the impact of piece rate pay in the transitioning US service economy. One potential difference worthy of further review is whether the types of workers who self-select piece rate work has changed over time; for example, if more disabled workers opt into the modern-day gig economy because of the flexibility and other amenable characteristics of the contract work setting, this will alter the observed relationship between performance pay and worker health. In this case, it would be important to look at variables such as disability status among other critical differences to properly control for worker self-selection and sorting to identify the relationship of pay type on health.

In summary, this research provides historical evidence to suggest that piece rate work has negative implications for US workers, particularly women, minorities, and the working poor. This article provides an underlying rationale for how these results might be extended to the gig economy; however, more work in this area is needed to understand and relate these results to modern-day work practices.

Author statements

Ethical approval

This study protocol and protection of subject confidentiality was approved by the Tufts Institutional Review Board and the Bureau of Labor Statistics.

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Competing interests

The authors declare that they have no competing interests.

Authors' contributions

M.D. was responsible for the study design, data analysis, writing, and revision of the manuscript. E.H. contributed to data collection, data analysis, and manuscript revision. All authors have read and approved the final version of this manuscript.

Data statement

Although the NLSY79 data set is publicly available, location characteristics used to assign region to workers in this study are confidential.

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Appendix

Table A-1 – Effect of piece rate on the odds of worker health limitations including health insurance.

Variable	Full model	Not low wage	Low wage	Male	Female	White	Non-white
Piece rate	1.80* (1.15–2.79)	1.66 (0.52–5.36)	1.78* (1.10–2.88)	1.82 (0.91–3.64)	1.80* (1.01–3.23)	1.47 (0.78–2.75)	2.13* (1.15–3.94)
Health insurance	0.97 (0.77–1.22)	0.51 (0.23–1.14)	1.02 (0.80–1.30)	1.06 (0.74–1.53)	0.92 (0.67–1.25)	0.89 (0.63–1.27)	1.06 (0.77–1.45)
Age	1.07** (1.02–1.12)	1.07 (0.96–1.19)	1.08** (1.03–1.14)	1.10* (1.02–1.20)	1.04 (0.98–1.11)	1.10** (1.03–1.18)	1.04 (0.97–1.11)
Manufacturing job	0.92 (0.71–1.17)	0.68 (0.37–1.25)	0.98 (0.75–1.27)	0.84 (0.58–1.21)	0.96 (0.68–1.35)	0.88 (0.62–1.25)	0.97 (0.68–1.03)
Tenure at primary job	0.96** (0.94–0.98)	0.99 (0.95–1.04)	0.96** (0.93–0.98)	0.98 (0.94–1.01)	0.95** (0.92–0.98)	0.93** (0.90–0.96)	1.00 (0.97–1.03)
Hours worked per week	0.99* (0.98–1.00)	0.97** (0.95–0.98)	0.99 (0.98–1.00)	0.97** (0.96–0.99)	0.99 (0.98–1.01)	0.99* (0.97–1.00)	0.99 (0.97–1.00)
Self-employed	1.44* (1.02–2.02)	1.20 (0.55–2.62)	1.48 (1.01–2.16)	1.32 (0.79–2.19)	1.55 (0.98–2.45)	1.61* (1.03–2.52)	1.28 (0.76–2.17)
Education	0.90** (0.85–0.95)	1.01 (0.91–1.12)	0.89** (0.84–0.94)	0.91* (0.84–0.98)	0.89** (0.84–0.96)	0.88** (0.82–0.95)	0.91** (0.85–0.97)
Non-white	0.78* (0.62–0.99)	0.74 (0.44–1.25)	0.78 (0.61–1.00)	0.70 (0.48–1.02)	0.82 (0.62–1.10)	N/A	N/A
Male	0.70** (0.54–0.90)	0.65 (0.37–1.13)	0.75 (0.57–0.98)	N/A	N/A	0.75 (0.52–1.09)	0.67* (0.47–0.94)
Low wage	1.72** (1.35–2.19)	N/A	N/A	2.31** (1.61–3.32)	1.33 (0.96–1.85)	1.53* (1.10–2.11)	2.02** (1.38–2.95)
Exercise (2002)	0.51** (0.41–0.65)	0.40** (0.23–0.70)	0.55** (0.44–0.71)	0.36** (0.24–0.52)	0.67** (0.50–0.88)	0.44** (0.31–0.61)	0.61** (0.45–0.84)
Diet (2002)	1.40** (1.11–1.76)	1.50 (0.91–2.49)	1.39** (1.08–1.77)	1.35 (0.93–1.97)	1.39* (1.05–1.86)	1.57** (1.13–2.18)	1.21 (0.89–1.66)
Smoker (1998)	1.65** (1.31–2.10)	2.24** (1.25–4.01)	1.55 (1.21–1.99)	1.63* (1.12–2.38)	1.64** (1.21–2.22)	2.02** (1.43–2.87)	1.29 (0.92–1.79)
N (observations)	22,653	7,880	14,773	11,088	11,565	11,912	10,741
N (individuals)	6,086	2,989	4,922	2,892	3,194	3,179	2,907

Odds ratios reported, 95% confidence interval in parentheses; model controls for survey year and census division (results not reported); **P < 0.01, *P < 0.05.

Table A-2 – Cumulative effect of piece rate on the odds of worker health limitations including health insurance.

Variable	Full model	Not low wage	Low wage	Male	Female	White	Non-white
Piece rate (ever any)	1.38 (0.98–1.93)	0.71 (0.30–1.68)	1.48* (1.04–2.11)	1.10 (0.66–1.84)	1.73* (1.10–2.71)	0.81 (0.48–1.39)	2.08** (1.35–3.20)
Health insurance	0.96 (0.76–1.21)	0.51 (0.24–1.10)	1.01 (0.80–1.29)	1.04 (0.73–1.49)	0.91 (0.67–1.23)	0.84 (0.60–1.19)	1.10 (0.80–1.49)
Age	1.06* (1.01–1.12)	1.08 (0.97–1.20)	1.08** (1.02–1.13)	1.10* (1.02–1.19)	1.04 (0.98–1.10)	1.10** (1.02–1.18)	1.04 (0.97–1.11)
Manufacturing job	0.93 (0.72–1.19)	0.67 (0.37–1.23)	1.00 (0.77–1.30)	0.81 (0.56–1.16)	0.99 (0.71–1.38)	0.91 (0.64–1.29)	0.97 (0.69–1.38)
Tenure at primary job	0.96** (0.94–0.98)	0.99 (0.95–1.03)	0.95** (0.93–0.98)	0.97 (0.94–1.01)	0.95** (0.92–0.98)	0.93** (0.90–0.96)	0.99 (0.96–1.03)
Hours worked per week	0.98** (0.97–0.99)	0.96** (0.94–0.98)	0.99* (0.98–1.00)	0.97** (0.96–0.98)	0.99 (0.98–1.01)	0.98** (0.97–1.00)	0.99 (0.97–1.00)
Self-employed	1.45* (1.06–1.97)	1.18 (0.57–2.46)	1.50* (1.07–2.12)	1.38 (0.87–2.19)	1.48 (0.97–2.26)	1.55* (1.03–2.35)	1.35 (0.84–2.17)
Education	0.90** (0.85–0.94)	0.99 (0.89–1.10)	0.89** (0.84–0.94)	0.90** (0.83–0.97)	0.89** (0.83–0.95)	0.88** (0.81–0.94)	0.91** (0.84–0.97)
Non-white	0.76* (0.61–0.96)	0.76 (0.45–1.28)	0.75* (0.59–0.96)	0.68* (0.47–0.98)	0.80 (0.60–1.08)	N/A	N/A
Male	0.70** (0.54–0.90)	0.69 (0.39–1.20)	0.74* (0.57–0.97)	N/A	N/A	0.79 (0.54–1.14)	0.64* (0.45–0.90)
Low wage	1.75** (1.37–2.22)	N/A	N/A	2.25** (1.59–3.19)	1.40* (1.00–1.96)	1.65** (1.20–2.28)	1.92** (1.32–2.80)
Exercise (2002)	0.52** (0.41–0.65)	0.39** (0.22–0.68)	0.56** (0.44–0.71)	0.36** (0.25–0.52)	0.67** (0.50–0.89)	0.44** (0.32–0.61)	0.61** (0.45–0.84)
Diet (2002)	1.39** (1.11–1.75)	1.49 (0.91–2.46)	1.37* (1.07–1.75)	1.40 (0.97–2.03)	1.37* (1.03–1.82)	1.59** (1.15–2.21)	1.18 (0.86–1.61)
Smoker (1998)	1.63** (1.29–2.07)	2.09* (1.17–3.73)	1.54** (1.20–1.97)	1.65** (1.14–2.38)	1.58** (1.17–2.15)	1.87** (1.32–2.63)	1.37 (0.98–1.90)
N (observations)	23,156	8,051	15,105	11,416	11,740	12,219	10,937
N (individuals)	6,102	3,023	4,972	2,900	3,202	3,188	2,914

Odds ratios reported, 95% confidence interval in parentheses; model controls for survey year and census division (results not reported); **P < 0.01, *P < 0.05.



Review Paper

Community exchange and time currencies: a systematic and in-depth thematic review of impact on public health outcomes



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ABSTRACT

Objectives: Austerity in government funding, and public service reform, has heightened expectations on UK communities to develop activities and resources supportive of population health and become part of a transformed place-based system of community health and social care. As non-monetary place-based approaches, Community Exchange/Time Currencies could improve social contact and cohesion, and help mobilise families, neighbourhoods, communities and their assets in beneficial ways for health. Despite this interest, the evidence base for health outcomes resulting from such initiatives is underdeveloped.

Study design: A systematic review.

Methods: A literature review was conducted to identify evidence gaps and advance understanding of the potential of Community Exchange System. Studies were quality assessed, and evidence was synthesised on 'typology', population targeted and health-related and wider community outcomes.

Results: The overall study quality was low, with few using objective measures of impact on health or well-being, and none reporting costs. Many drew on qualitative accounts of impact on health, well-being and broader community outcomes. Although many studies lacked methodological rigour, there was consistent evidence of positive impacts on key indicators of health and social capital, and the data have potential to inform theory.

Conclusions: Methodologies for capturing impacts are often insufficiently robust to inform policy requirements and economic assessment, and there remains a need for objective, systematic evaluation of Community Exchange and Time Currency systems. There is also a strong argument for deeper investigation of 'programme theories' underpinning these activities, to better understand what needs to be in place to trigger their potential for generating positive health and well-being outcomes.

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Introduction

The evidence base on disadvantage and poor health outcomes is well established.^{1–3} Recent public health guidance promotes community-engaged approaches encouraging social cohesion and social contact, mobilising local 'assets' and building 'social capital' with knock-on effects to health, well-being and community 'resilience'.^{4,5} The case for addressing poor health and well-being through such initiatives has a growing following, including examples described as 'Time Currencies' or 'Time Banking'.

Time Banks are a form of Community Exchange activity with value linked to time.⁶ One hour spent helping another member of the network is worth one Time 'Credit', which can then be used to buy someone else's time,⁷ or access a service. Community organisations often provide the structure for giving and receiving services in exchange for time credits.

There is considerable variation in Community Exchange from the 'host' sector (e.g. primary care, public health, community development) to the 'target' population, influencing both form and function. Largely supporting the non-monetary economy made up of family, neighbourhood and community activity, some variants allow Time Credits to be exchanged for goods, or supplemented by cash payments, whereas many issue paper currency. Other examples like UK-based Spice Time Credits (now 'Tempo') facilitate

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person-to-agency and agency-to-agency exchanges.^{8,9} Local Exchange Trading Systems (LETSs) use a similar system of community credits, rather than direct exchange.¹⁰ People provide a service to earn credits, which they can spend with other members, e.g. on childcare, transport, food, housework, home repairs.

UK Time Banking has grown steadily since the late 1990s,^{11–13} more recently with impetus coming from a perceived role in rebuilding social networks and neighbourhood support to compensate reduced social spending.^{13,14} Examples of more recent Time Credit initiatives include several in Welsh regeneration areas.¹⁵ Both Time Banks and LETS promote a 'social' purpose in bringing communities together, with Time Banks especially highlighting reciprocity and equality. Anticipated outcomes include practical gain (through 'spend'), as well as 'process' outcomes associated with 'earning'. Specifically, health benefits are associated with participation in community activity (e.g. volunteering) and link to concepts of 'social capital' and 'coproduction',¹⁶ both of which are featured in Public Health England's 'family of community-centred approaches to health and well-being'.⁵

Policy interest and corresponding local investment in these types of interventions means investigation of their longer term effectiveness is timely.¹⁷ This review links to a local evaluation of a national Time Currencies model,¹⁸ an example of coproduction between public authorities, third-sector organisations and local communities.

It is relevant to public health challenges, in the UK and elsewhere, where austerity, self-management and localism are political and economic drivers of public services. It is also pertinent to the promotion of choice, coproduction in health^{19,20} and the 'people-powered health' discourse,²¹ alongside asset-based approaches in health.²²

Materials and methods

This PROSPERO-registered review intended to capture the range and strength of evidence in relation to two questions:²³

1. What evidence is there of the effectiveness of Time Banking, Time Credits and LETS on population health and economic outcomes?
2. What approaches are used to evaluate the effect/impact of Time Banking, Time Credits and LETS?

Searches

Electronic databases and websites were searched using a wide range of search terms covering concepts for Time Banking, Time Credits and LETS individually, combined with terms covering domains of Health and Well-being, or Economic or Financial benefit or Evaluation or Outcome Analysis. The full list of databases and strategies is available in [Additional file 1](#).

Inclusion and exclusion criteria

Studies and evaluation reports published from 1990 onwards in English, French and Spanish were included, without restriction on study type providing there was primary data collection. Systematic reviews were excluded, but references checked for primary studies. Any type of Community Exchange/Time Currency system was included, yet those with predominantly economic goals rather than social goals – barter systems, alternative currencies, loyalty cards – were excluded. Populations were unrestricted and included disadvantaged subgroups, though initiatives with narrow

behaviour-focused incentives (e.g. immunisation take up, improving school attendance, waste recycling) were excluded.

Primarily, we were interested in general and specific health and well-being outcomes reported systematically through validated instruments and/or self-report. We sought outcomes that provided indicators of impact on health status at individual or community level, including measures of uptake and maintenance of healthy behaviour, well-being and quality of life. Of secondary interest were outcomes showing that Community Exchange systems are capable of acting on determinants of health, as illustrated in the conceptual model ([Fig. 1](#)).¹⁷ We sought to capture indicators that included impact on self-esteem, skills, confidence, employment, loneliness and social exclusion. At community level, we looked for indicators of community cohesion and resilience, social capital and social networks. We were also interested in any evidence of impact on health and social care delivery, including cost, cost-effectiveness and cost-benefit studies.

Data extraction and analysis

Data were extracted on intervention, study design population and setting, methods of data capture, analysis, outcomes and key themes. To ensure accurate reporting, extraction tables were piloted independently by three reviewers.

Titles, abstracts and papers were screened for inclusion by two reviewers, with differences resolved by discussion. Two researchers independently assessed study quality using an approach adapted by Bunn et al.,^{24,25} rating according to common features including aim/purpose, design, approach to data collection and analysis, reliability/validity and generalisability/transferability. Overall articles were rated low, medium or high for reliability and usefulness. Twenty percent of studies were double assessed, and none were excluded on the basis of quality.

A narrative approach to evidence synthesis was taken,^{26,27} as the most appropriate to the range and quality uncovered (refer following sections). This focused primarily on synthesising findings on impact, using text and tables to describe studies and themes to analyse content. We also attempted to capture evidence about why particular interventions work, for whom and in what circumstances and summarised evidence linking impact to key concepts and theories, such as reciprocity, social capital theory and citizenship,^{28–31} referred to in several articles.^{32–40}

We began with a content analysis, providing an overview of included studies by principle features ([Table 1](#)), and then aggregated key findings and thematic summaries of evidence on primary and secondary outcomes. We then moved towards an interpretive approach, with key outcomes and concepts forming the thematic framework.^{41,42} Finally, we highlighted where additional themes identified could be explored by working through propositional statements (what works, for whom, in what circumstances, why and how?), with potential for realist analysis.⁴³

Results

The searches for primary studies and grey literature located 5716 articles after removing duplicates, yielding 222 relevant titles and abstracts. A total of 104 full articles were assessed, with a final 38 articles included in the review ([Fig. 2](#)).

The included studies comprised: 38 peer-reviewed publications; 14 (evaluation/end of funding) reports; one working article; one book; one thesis and one 'magazine' article. Twenty-eight papers were related to Time Banking, seven to LETS and four to 'other' Community Exchange.

Overall the quality of studies was assessed as low – just seven were judged to be high/moderate quality, and only four of these of

HOW EARNING AND SPENDING TIME CREDITS CAN LEAD TO POSITIVE HEALTH OUTCOMES

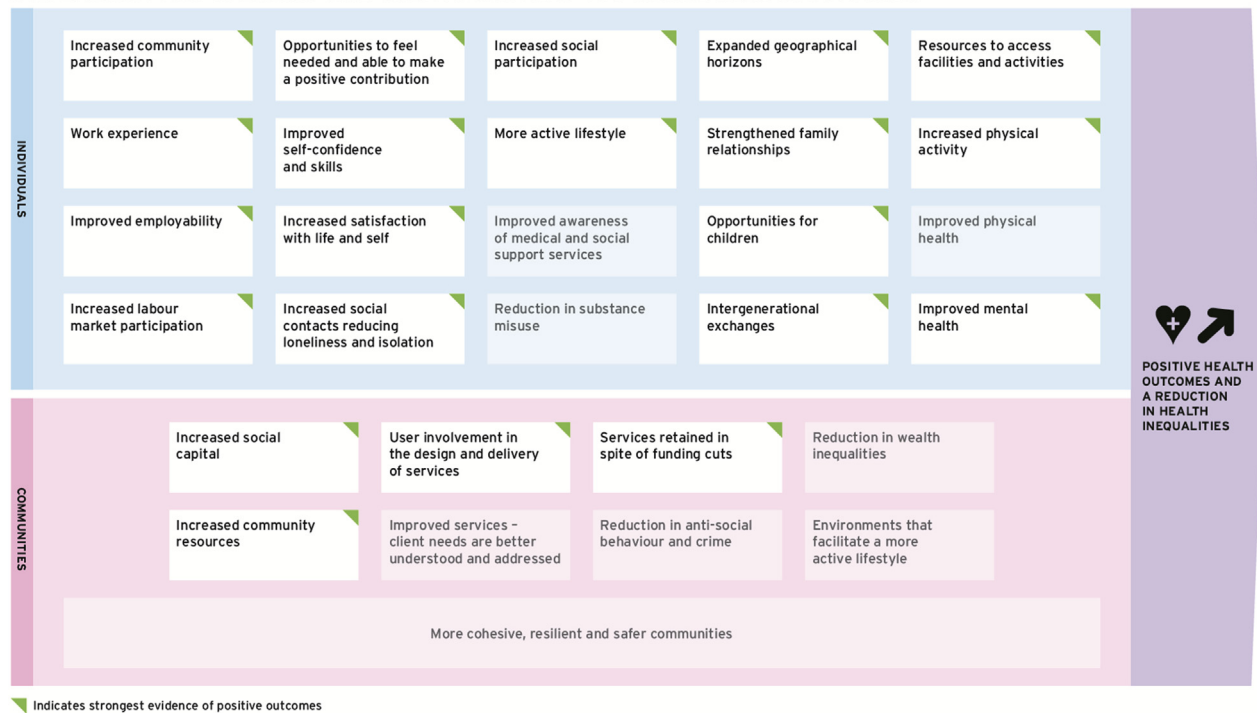


Fig. 1. Conceptual model of potential time credit impact on individuals and communities. Source: Burgess 2017.¹⁸

high/moderate utility to this review's objectives. Moreover, two referred to the same Time Currency project. Refer Table 1.

Findings

Evaluation approach

Many studies relied on self-administered questionnaires and interviews, precluding outcome comparison or metaanalysis. A majority ($n = 25$) were relatively small scale 'case studies' or local evaluations reporting impact on individual participants (Table 1). Almost half ($n = 17$) were interested in the process of development/growth of a Time Bank and impacts on the community as a whole. Around a quarter attempted to link aspects of process and outcome, exploring associations between participation and demographics, and what makes a difference to people's lives – the 'how' and 'why' of Time Currencies.^{35,36,44–50} There were no experimental studies, and only one used a form of quasi-experimental design.³⁷ Most used qualitative methods and were descriptive.

Only five of 20 studies with a focus on health outcomes used a scale to measure impact over time on health and well-being,^{33,44,45,51,52} while none reported economic costs. Only two studies applied statistical techniques to assess strength of associations with health-related outcomes.^{44,45} These predominantly looked at the relationship between positive outcomes, strength of outcome and characteristics of individuals or levels of participation. The remaining studies reported qualitative accounts of impact on health and well-being. Less than a third ($n = 10$) attempted to 'quantify' impact on community capacity or social capital, those doing so by counting the number of new groups created, or applying social network or transaction analysis.^{28,32,35,39,44,45,47,53–55} One

longitudinal study focused on recording community 'capacity building' outcomes.⁵⁶

The majority of articles were evaluations of UK Time Banks, serving disadvantaged communities and highlighting issues of social exclusion. Three were hosted in primary care settings, and participants with poor mental health or less than 'good' general health were typically targeted. Outcomes frequently included impact on individuals' health, well-being, employability and reduced isolation, although community benefits were also emphasised.

Outcomes

Table 2 summarises the content analysis of the included studies. Broader outcome types are broken down into more specific outcomes and concepts, providing a framework for more detailed thematic synthesis.

Table 3 presents a detailed summary of outcomes reported by each included study, making links to the theoretical concepts previously highlighted. It covers indicators of change in physical health, mental health and emotional well-being, as well as indicators of quality of life, economic impacts and impact on communities.

Physical health

Using retrospective self-report, one study reported 18.1% of members responding ($n = 160$) physical health gains since joining their Time Bank, whereas most members reported physical health had 'stayed the same' (78.8%) and 3.2% a worsening. Similar proportions reportedly experienced improvements or deteriorations in 'general health', and the majority (81.3%) experienced no change at

Table 1
Summary characteristics of selected studies: Study objective, methods and analysis.

Ref/Author	Year	Study type	Country	Community Exchange type ^a	Theme/study objective	TB Participant profile	Quality assessment	Assessment of usefulness
Apteligen ⁵⁸	2014	Evaluation across multiple sites	UK	TB	Impact on individuals (broad)	Varied, disadvantaged localities	–	+/-
Boyle ⁵⁷	2006	Evaluation	UK	TB	Impact on individuals, inc well-being, employability, social capital	Female, youngish, rental, high chronic medical conditions, high MH problems, high level of benefits claimed, low income	+	+
Bretherton ⁶⁰	2014	Action research evaluation	UK	TB	Social inclusion, employability	Male, high prop BAME, young, homeless/vulnerably housed	+	++/+
Burgess ⁵¹	2014	Multisite evaluation	UK	TB	Impact on individuals, cost savings	Relatively high proportion in good health, a sixth are carers or use care/support services	–	–
Burgess ⁵³	2016	Evaluation	UK	TB	Social inclusion, impact on well-being, social capital	Disadvantaged locality	–	–
Collom ⁶⁶	2007	Survey	US	TB	Impact on individuals	Female, older, educated, unemployed, low income	++	+
Collom ³²	2008	Social network analysis	US	TB	Social capital, demography of volunteers	Female, fewer elderly	++	+
Collom ⁴⁴	2012	Study of outcomes/evaluation of three TBs	US	TB	Impacts on individual, including health	Female, educated, low income	++	++/+
Dabbs ⁵²	2016	Evaluation	UK	TB	Impact on individuals, health, well-being, employability	Deprived locality (3–10% most deprived nationally), isolated, low mental well-being	+/-	+
Feder ⁶²	1993	Evaluation – review of demonstration sites	US	TC	Impact on attracting volunteers and building organisational capacity	Older than 55 years, less than good health (but not requiring daily assistance)	–	+
Gimeno ³³	2001	Study/evaluation of impact	UK	TB	Health impacts, theory testing	GP patients, predominantly female, with range of other characteristics and age range	+	+
Hall Aitken ⁵⁴	2011	Evaluation	UK	TB	Behaviour change; social capital	Less mobile/sick, mental health; retired; young parent. (vulnerable)	–	–
Jacob ³⁴	2004	Single-site case study	US	TB	Participation/engagement (building social capital)	Not targeted	+	–
Lasker ⁴⁵	2011	Survey of time bank members	US	TB	Investigate health gains and variables influencing health benefits.	Targets disadvantaged, elderly	++	++
Lee ⁶⁷	2009	Evaluation/Review	UK	TB	Social cohesion, inclusion, combating isolation	Relatively isolated, disability/impairment, mental health, high proportion elderly	–	–
Letcher ⁴⁶	2009	Evaluation case study (CBPR)	US	TB	Impact on well-being, theory testing	Majority female, isolated, disabilities and mental health	++	++
Manley ⁶⁸	2000	Evaluation/Case study	UK	LETs	Social inclusion	Mental health difficulties	–	–
Molnar ³⁵	2011	Evaluation	Sweden	TB	Social capital	Unknown	+/-	+
Nakazato ⁴⁷	2012	Case study	Japan	LETs	Social capital	Female, elderly	–	–
NEP ⁶⁹	2002	Impact study/evaluation	UK	TB	Impacts on organisational culture (specifically National Health Service (NHS) primary care), individuals and social capital	GP patients, inner city	–	–
Ozanne ³⁶	2010	Evaluation	New Zealand	TB	Social capital	Better educated, income, home owners – atypical of area	+	–
Ozanne ⁵⁶	2016	Ethnographic study (including outcomes)	New Zealand	TB	Community capacity building	Better educated, income, home owners – atypical of area.	++/+	+

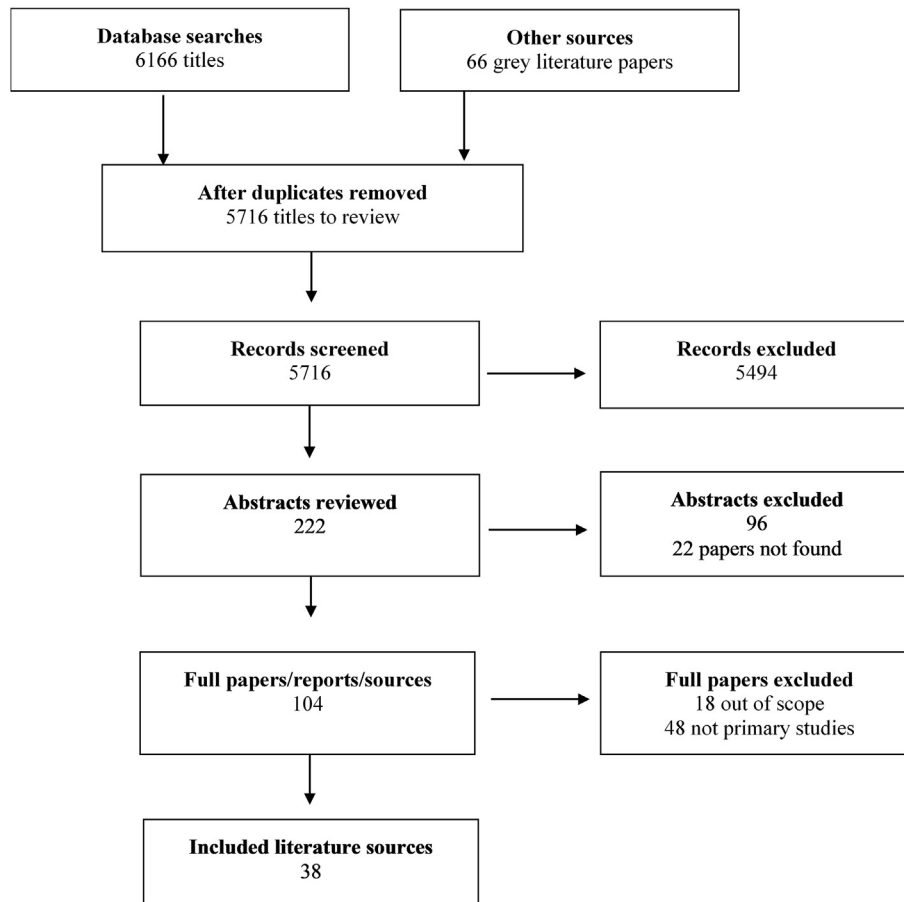


Fig. 2. The Flow chart for study selection process.

particular characteristics and positive impact on 'general' or physical health.^{44,45}

There was also some evidence of an increase in overall 'activeness' in previously sedentary individuals, whether simply 'getting out of the house'^{57–59} or becoming involved in 'credit' activity that got them moving.⁵¹

Table 2
Outcomes and related concepts by number of studies reporting.

Outcome type	Outcome concepts	# Studies reporting
Primary health outcome	Physical health (including 'general health gains')	11
	Mental health (including any reference to 'well-being')	12
Secondary health-related outcomes	Psychological and psychosocial impact (e.g. 'Connectedness', Self-esteem/self-confidence/self-worth)	25
Community/organisational outcomes	Organisational outcomes/organisational capacity	1
	Community 'cohesion'/social capital	24
'Economic' outcomes	Increased skills/employability	12
	Practical/instrumental benefits (including saving money, greater access to goods or services)	14
	Cost and/or cost benefit	0

Forty-five percent of responding 'Spice' Time Credits members ($n = 1102$) reported 'feeling healthier' since earning Time Credits: 66% 'wanted to do more', 71% 'felt able to do more' and 68% 'were regularly doing more'.⁵⁸ Nineteen percent said they 'have less need to go to the doctor' and another 19% had 'less need to use social care services'.

Other studies reported only a slight health improvement.³² In a UK Primary Care Time Bank, 43% ($n = 38$) agreed it had helped them to do more regular physical activity and 36% said it had helped them manage chronic health problems better.⁵⁹

Mental health and well-being

There is consistent evidence from three moderate/high-quality studies that time currency involvement impacts positively on mental health and well-being.^{44–46} Time Bank involvement had a positive effect on 33.3% ($n = 160$) in one study,⁴⁵ particularly for those making more exchanges. Two thirds of participants, who had become more active, reported mental health gains, compared with just over a tenth with fewer exchanges.

High levels of depression, loneliness, anxiety and negative stress were observed across all Boyle's Time Bank case study sites.⁵⁷ Participation in exchanges provided not only better access to social networks but also direct access to alternative therapies, self-management and self-help activities. In one setting, Time Credits could be spent in non-core programmes offered by the mental health National Health Service (NHS) trust.

Another UK Primary Care Time Bank reports that mood was 'enhanced' for both depressed and non-depressed members, as a result of the scheme.³³ Similarly, Paxton Green Time Bank reportedly alleviated 'symptoms of depression and other

Table 3
Thematic analysis of outcomes.

Ref/Author	Year	Primary health outcomes reported and related concepts e.g., improved physical health or mental health/well-being; psychological; psychosocial and behavioural impacts	Secondary health outcomes and 'community' outcomes reported and related concepts e.g., social capital: bridging, bonding/linking, trust; community capacity building; social, economic and political citizenship; employability; psychological, psychosocial and behavioural impacts
Apteligen ⁵⁸	2014	Feel healthier; able to do more, regularly doing more (well-being and physical health)	Built social network (Social capital/connectedness) Employability, economic capital; empowerment Practical/instrumental needs met Quality of life (economic citizenship, psychosocial)
Boyle ⁵⁷	2006	Increased health, well-being (psychological and behavioural impacts)	Confidence and social networks: self-esteem, employability, social reach (social citizenship, economic citizenship, social capital)
Bretherton ⁶⁰	2014	No primary health outcomes reported	Engagement (social citizenship); sense of dignity and of self-worth, self-esteem, achievement, being valued; (psychological impact) access and acquisition of skills (psychosocial impact) and learning/accredited education, more able to secure paid work (economic citizenship, employability)
Burgess ⁵¹	2014	Improvement in self-reported health (slight).	Marginal employment and household impacts (economic citizenship); increased numbers of acquaintances in local community (social capital)
Burgess ⁵³	2016	Improved physical and mental health	Reduced loneliness and social exclusion (social citizenship) Improved confidence (psychological impacts) Feeling of making a positive contribution (psychosocial impact) Skills development (economic citizenship; social citizenship)
Collom ⁶⁶	2007	No primary outcomes reported	Building community, creating a 'better' society; Ability to get services needed (practical/instrumental gains, economic citizenship; community capacity building).
Collom ³² Collom ⁴⁴	2008 2012	No primary outcomes reported Personal and community 'growth' Collective capacity (community capacity building; social capital)	Source of social integration of elderly ('bridging' capital) Community Exchange (CE): Social support outcomes rated highly (bridging capital). 'self-efficacy' gains (a minority) (psychological impacts) Community involvement (some increase) (social capital) Money saved (economic impact) (HEP): more cultural capital (less economic or social) (social capital) Member to Member (M2M): Social outcomes top reported benefit (inc. being 'more connected', (social capital) followed by gaining resources, receiving needed services that help them to get by (practical/instrumental gains; economic citizenship).
Dabbs ⁵²	2016	Happiness and fulfilment; physical and emotional well-being (psychological and behavioural impacts)	Self-confidence/self-esteem (psychological impact); social connectedness/reducing social isolation (psychosocial impact); social capital
Feder ⁶²	1993	No primary outcomes reported	Primary benefit to sponsoring organisations is ability to extend their service missions (organisational benefit, community capacity building?) Enjoying company of volunteers, worrying less than before about getting important tasks done, or having to move from their homes (psychosocial and psychological impacts) 'social connectedness aspects' (social capital)
Gimeno ³³	2001	Psychological impact (e.g., mood, coping - enhanced mood, groups can benefit emotionally);	New contacts, friends, perceptions of support, sense of belonging (psychosocial impact); keeping busy, going less to doctor, going out more ('behavioural impact'). Community impact: (not) yet produced a significant impact on local community as a whole UK
Hall Aitken ⁵⁴	2011	Well-being Physical health impacts, (n.b. multi-component project, Physical health outcomes not attributed to TB alone)	
Jacob ³⁴	2004	No primary outcomes reported	Quality of life, relationships, self-confidence, new skills (psychological and psychosocial impacts); access to goods/services (practical/instrumental gains) Establishing and extending relationships of trust (social capital)
Lasker ⁴⁵	2011	Physical health gains, mental health (psychological and behavioural impacts)	Level of social support had increased a little or greatly. Increased 'self-efficacy'
Lee ⁶⁷	2009	No primary outcomes reported	Making friends/well-being, (psychological and psychosocial impacts) Getting involved in community, (engagement, social capital) Keeping brain active (behavioural impact)
Letcher ⁴⁶	2009	Health promotion and improved well-being (psychological and behavioural impacts)	Personal and community 'growth'
Manley ⁶⁸	2000	No primary outcomes reported	Collective capacity (community capacity building; social capital) Confidence/self-esteem/self-worth (psychological impacts) Resilience Social contact (social capital)
Molnar ³⁵	2011	No primary outcomes reported	Development of skills, employability (economic citizenship) 'Empowerment' (political citizenship) and social capital – generalised reciprocity rather than direct reciprocity, but overall lack of bridging capital
Nakazato ⁴⁷	2012	No primary outcomes reported	Social support (emotional, instrumental, informational, appraisal)
NEF ⁶⁹	2002	No primary outcomes reported	economic and social companionships/citizenship

(continued on next page)

Table 3 (continued)

Ref/Author	Year	Primary health outcomes reported and related concepts e.g., improved physical health or mental health/well-being; psychological; psychosocial and behavioural impacts	Secondary health outcomes and 'community' outcomes reported and related concepts e.g., social capital: bridging, bonding/linking, trust; community capacity building; social, economic and political citizenship; employability; psychological, psychosocial and behavioural impacts
Ozanne ³⁶	2010	No primary outcomes reported	Confidence and self-esteem (psychological impacts) Widened social networks and trust (bridging capital) Access to preventative and reactive care (practical, instrumental needs) Builds connections and increases trust among members, (social capital) Reinforces 'weak' ties in the communities (bridging/linking capital)
Ozanne ⁵⁶	2016	No primary outcomes reported	Social capacities – connecting people, making them feel safer'. (bridging and bonding capital); building cultural capacities; building community competencies (community capacity building)
Ozawa ⁷⁰	1994	No primary outcomes reported	'To help others', 'do something meaningful', meet other people (psychosocial impacts). 'To earn credits for future use' (practical/instrumental benefits)
Pacione ⁷¹	1998	No primary outcomes reported	Economic advantages, 'local people servicing local people' (practical/instrumental benefits) Develop social contacts (social capital, engagement), 'mix with like-minded' (bonding capital)
Richey ³⁷	2007	No primary outcomes reported	Increase in 'generalised trust' (social capital – bridging/linking)
Sanz ³⁹	2016	No primary outcomes reported	Social capital
Seyfang ³⁸ (<i>Environ Plan</i>)	2001	No primary outcomes reported	Improved quality of life (economic citizenship, psychosocial) Obtained goods and services couldn't otherwise afford (instrumental/practical gains) built self-esteem (psychological impacts). 'greener lifestyle' impacts: sharing, recycling (community capacity building)
Seyfang ⁷² (<i>Work Employ Soc</i>)	2001	No primary outcomes reported	New opportunities to earn income, employability, (economic citizenship), Life enhancing services (instrumental/practical/quality of life benefits) More involved in community life, enabling people to make contact, friendships, meet people (psychosocial impact). Self-confidence (psychological impact)
Seyfang ⁷³ (<i>Voluntary Action</i>)	2001	No primary outcomes reported	Encouraging community involvement, engaging socially excluded groups (social capital and bridging capital) Meeting needs (instrumental/practical gains)
Seyfang ⁴⁹	2002	No primary outcomes reported	Social citizenship; economic citizenship; political citizenship
Seyfang ³⁹	2003	No primary outcomes reported	Self-esteem and self-confidence (psychological impact). TB an additional source of support or channel to offer support to others (practical/instrumental gains) Involvement with local community groups; new contacts, met like-minded people. (bonding capital) Bridging social divides and bringing people would not normally meet together (bridging capital). Building community capacity Promoting social inclusion (social capital)
Seyfang ⁷³	2004	No primary outcomes reported	Asking for and receiving help. (practical/instrumental) More in control of lives, quality of life, self-confidence, (psychological and psychosocial impact) feeling valued (political citizenship and social inclusion). Gained or developed skills (economic citizenship)
Seyfang ⁵⁰	2005	No primary health outcomes reported	Social citizenship: connecting people, e.g., young and old (bridging capital), meeting like-minded (bonding capital). Self-esteem, confidence (psychological impacts)
SPICE ⁷⁴	2015	Well-being Physical health	Social capital, improved relationships between professionals and members of the community (bridging capital)
Virani ⁵⁹	2016	Alleviating symptoms of depression and other chronic health problems (psychological impact); More regular physical activity. (behavioural impacts)	Money saving (practical/instrumental); Sharing and developing new skills (economic citizenship). Reducing social isolation (social capital) Increasing trust in people from different backgrounds (bridging capital). 'Quality of life' (practical/instrumental) Managing chronic health problems better (self-efficacy – psychological impact)
Warne ⁵⁵	2009	Physical health gains from activities helping others (behavioural impact) Mental health especially (psychological)	Personal coping, self-confidence (psychosocial impact) Social isolation reduced (social capital)
Wheatley ⁴⁰	2011	No primary health outcomes reported	Community engagement, social capital

TB, Time Bank.

chronic health problems': 76% of participants ($n = 38$) agreed it had helped to lift their mood, 68% agreed it had made them feel better about themselves, 67% agreed it had reduced loneliness.⁵⁹

Impact on secondary outcomes of interest

Many studies reported on 'quality of life' gains, yet none used validated/recognised measures to capture this outcome: 65% of Spice members ($n = 1102$) reported that Time Credits improved their quality of life, a percentage increasing the longer they remained involved.⁴⁹ Other programmes reported 74% ($n = 38$)⁵⁹

and 32% ($n = 21$)⁵⁰ of respondents, respectively, had improved quality of life. Several studies reported outcomes of secondary interest to this review, capturing the richness and complexity of the potential mechanisms at play.

Economic aspects

Studies frequently report positive contributions to the community (through work experience, helping others), in addition to increased access to activities and services previously out of reach. Although these 'practical gains' entailed a potential cost saving, no studies specifically measured economic impacts or modelled possible savings to society.

There is consistent, if relatively weak, evidence that involvement in time currencies impacts positively in developing members' skills and employability, e.g., 17% of 1102 survey respondents agreed they had learnt new skills (53%, $n = 38$ at Paxton Green),⁵⁹ 14% gained some work experience and 3% gained employment.⁵⁸ Studies consistently report on the positive impact of 'meaningful activity' for populations who are particularly disadvantaged, economically and otherwise. For example, the Broadway Time Bank reportedly helped 73 homeless people gain employment and access accredited education.⁶⁰

Psychological and psychosocial impacts

In terms of factors influencing mental health and well-being, studies often referred to benefits such as reduced loneliness, strengthened friendships and wider relationships, as well as impacts on individuals' sense of purpose and awareness of their own abilities. Lasker et al.⁴⁵ compared participants' 'self-efficacy' ratings before and after joining 'Community Exchange', finding that 29.4% participants ($n = 160$) had an increase in their scores. Although boosted self-confidence was negligible in Seyfang's sample,⁵⁰ just less than half (42%) felt enabled to get out and about more – important given the infirmity level of many participants. Of the 1102 participants in 'Spice' Time Credits, 58% felt more confident; 49% less isolated, 52.7% more useful/needed and 57.9% felt they had something to offer society.⁵⁸ Reporting on friendships and reduced social isolation 83% of Virani's Time Bank respondents ($n = 38$) said it helped them make more friends in the local community.⁵⁹ Gimeno³³ found that most Rushey Green Time Bank participants had made more than three new contacts; whereas 68% of 1102 Spice Time Credit respondents got to know more local people through the project.⁵⁸

Who benefits most?

The studies by Collom⁴⁴ and Lasker⁴⁵ reported on the same U.S. Time Bank (Community Exchange) and tested associations through modelling. Both studies suggest that young members, those who live alone, and society's poorest members may benefit most from involvement in these sort of schemes. All three of these groups were more likely to report generic health, mental health and physical health gains.

Social capital

Reference to community 'cohesion' and 'social capital' was common (24 articles). In one example, more than half of 160 Time Bank respondents (51.2%) said their level of social support had increased as a result of membership.⁴⁵ Similarly, 42% other respondents had learnt about additional sources of support in their community.⁵⁰ Forty two percent of (1,102) respondents were reportedly more likely to get important needs met 'because they are part of their local community', with 26% better able to manage independently in their own home as a result of the Time Bank support network.⁵⁸

The most robust study examined the impact of a New Zealand Time Bank set up just before the 2009 and 2011 earthquakes.⁵⁶ The Time Bank provided a focus for community efforts for disaster relief and may have been a catalyst to capacity building:

'Initially these capacities were activated to encourage trades meeting individual needs. Progressively, the TB (Time Bank) community was effectively executing larger projects meeting community needs... creating a culture of caring where TB members worked for the well-being of its members and town.' (p. 341)

Many studies reported evidence on 'bonding' capital (making connections with similar people) and 'bridging' or 'linking' capital (making connections with different people, e.g., age, race, socio-economic group).⁶¹ In the Spice Time Credits evaluation ($n = 1102$), 53% participants met like-minded people, whereas 47% spent time with people from different backgrounds and ages.

A smaller number reported 'political citizenship' impact, synonymous with ideas of empowerment, engagement and decision-making. One Time Bank study 47% ($n = 21$) claimed it helped make their neighbourhood a better place to live.⁵⁰ Another survey ($n = 1102$) found even higher endorsement of growth in community engagement, with 73% taking part in more activities and 50% feeling more able to influence their community.⁵⁸

Only one study recorded benefits to the host organisation.⁵³ This was detailed as an expansion of 'mission', with Time Bank activities enabling it to build capacity, extend and expand its service offer (to older adults).

Conceptual analysis and theory of change

The outcomes evidence discussed previously do not demonstrate causality. Clearly other factors may be at play in the wider context, or an individual's immediate 'environment', with potential influence on outcomes. This is why we suggest there is value in organising some of the outcomes put forward alongside conceptual ideas in support of our theoretical understanding, shedding light on what works, for whom and under what circumstances (Table 4).

Table 4 organises data according to propositional statements relating to key concepts in, and developed from, the literature, identifying likely context, mechanism and outcome configurations. For example, there may be support for Berkman's⁶³ conceptual model of how social networks impact health. Under the heading of 'reciprocity', we suggest that contributing in ways that people deem meaningful engenders a sense of 'giving back'; that increasing frequency of opportunities for exchange makes interacting with others seem more 'normal' and consequently that people feel more trusting of others and confident to interact. It is also possible that the opportunity to produce 'something' tangible makes people feel more able and self-confident and more ready to engage with learning or seeking work (employability). Similarly, as links are built between people and organisations (engagement/social capital), so there is capacity to address issues and mobilise resources to meet needs at greater scale. Another example could be feeling 'connected' to the organisation, increasing perceptions of improved health, as well as reflecting a relative absence of other social ties.

Discussion

The evidence summarised in this review allows us to propose some generalisations in support of Time Currencies' value. However, the low-quality assessment given to many studies shows a variety of weaknesses: e.g. poor study design, insufficient reporting of methodologies. Many studies were also too small to offer

Table 4
Identifying potential context, mechanism and outcome in time currencies.

Propositional statement (IF... THEN...)	Context	Mechanism	Outcome	Supporting data
Key concepts: Reciprocity; Employability				
If participants feel there is give as well as take, then they have dignity and self-worth	Disadvantaged populations (e.g., homeless)	Perception of reciprocity	Reducing health and mental health risks	"Time Banking emphasized the role of exchange which it was thought gave Broadway clients a greater sense of dignity and of self-worth." ⁶⁰
If activity is meaningful, participants will be less bored.		Participants attach value to the activity	Social Psychosocial Economic	"Time Banking was valued by some Broadway clients because in their view it could help lessen those (drug and alcohol) risks." ⁶⁰
If participants are less bored, they will use less drugs and alcohol.	Boredom Social isolation Stigma		Engagement of non-traditional volunteers	A natural "receiver" of services describes his new role: "I knew there were a lot of things that I needed, but I couldn't think for myself what I could offer. (...) I was in a position as a retiree to be able to offer all kinds of services, some of which I did not realize that I was capable of performing." ⁴⁶
If they use less drugs and alcohol, they will have less mental health issues.				
If activity is meaningful, then participants will gain skills.				"Several clients spoke of how they had, for the first time in a long time, felt able to communicate with others again and as a result had a new desire to participate in group activities." ⁶⁰
If activity is meaningful, then participants will gain skills.				
If participants gain meaningful and tangible outcomes, then they will be more equipped for work and learning.				
If participants engage, they will be less isolated.				"Broadway clients (...) often felt more able, capable and better equipped to engage with work and learning, as well as paid employment, as they built up experience through Time Banking." ⁶⁰
Key concepts: Social capital; Capacity building; Empowerment				
Time banking benefits different socioeconomic groups in different ways	Socio-economic factors demographic factors	Trust Empowerment	Strength and type of outcome Economic gains Practical gains Health gains	"Younger members more likely to gain help meeting economic needs, accessing things they want, and to gain health-related outcomes; Lower income members more likely to report gaining wants and health outcomes; Living alone more likely to report physical health gains, younger more likely to report improvements in self-efficacy and mental health, unemployed more likely to report civic engagement outcomes." ⁴⁴
If there is a programme of social participation and engagement in community activities, then 'generalised trust' can be built.			Mental Health gains Community engagement	"We're a self-supporting program and we have to make it work, because if we do not do it, it is not going to work." The network is strengthened as more participants engage together in planning and organisation, from specific 'tasks' and activities, to becoming a pool of support for when people need help." ⁴⁶
If a programme has sustained growth, it can build greater capacity to support its community.			Practical support Enabled to remain independent Social outcomes Creation of community capacity Trust – more/less	"Initially activated to encourage trades meeting individual needs. Progressively, the TB community was effectively executing larger projects meeting community needs (...) creating a 'culture of caring' and community solidarity." ⁵⁶ "The Tekona program changed the

Table 4 (continued)

Propositional statement (IF... THEN...)	Context	Mechanism	Outcome	Supporting data
				participants' political behaviour by promoting community involvement. Institutional promotion of participation is associated with more trustful feelings when comparing with people who are very similar. Age decreases trust. Being male and having more income increases trust. Home-ownership has a strong negative effect on trust. City use and informal social networks significantly increase trust. ³⁷
Key concept: Connectedness If a participant lives alone, they will be more likely to perceive an improvement in their physical health (than someone who lives with other people).	Living alone	Feelings of attachment to the TB organisation.	Physical health gains Mental health gains	Multivariate analyses: physical health improvement attributed to membership significantly predicted by attachment to the organisation and living alone. A greater impact on those living alone (i.e. potentially most isolated), although 'living alone' variable had large confidence interval. ⁴⁵
If a participant feels connected to the TB (Time Bank) organisation, they are more likely to report improvements to physical and mental health.		Making numerous exchanges	Mental health gains	Mental health gains predicted by general health changes, average number of exchanges, and attachment to the organisation. ⁴⁵

generalisable insights or outcomes of direct relevance.⁴¹ As Snilstveit et al.²⁶ note in relation to international development research, 'the boundaries between research and advocacy are often blurred, and such material needs to be treated with caution'. Evidence synthesis intended to inform policy requires rigour, trustworthiness and methodological clarity.

The overall evidence of direct health impact here is neither reliable nor generalisable. However, there are positive 'stories' associated particularly with individuals who were isolated and inactive, as well as Time Banks whose credit activities are expressly linked to physical pursuits and active leisure activities. There is also a consistent narrative of improved mental health and well-being. While limited evidence was found in relation to economic benefit, several studies report improved 'employability' of participants and there was some evidence of positive impact particularly for lower income beneficiaries. It is also worth remembering that Time Currencies and Community Exchange are generally modestly resourced and context-sensitive interventions.

This review offers interesting findings to practitioners and policymakers in the context of 'health in all policies' and a boom in Social Prescribing initiatives.^{64,65} The crisis in public funding has fostered heightened expectations that communities will develop resources in support of population health, becoming part of a transformed place-based systems of community health and social care. There is a strong argument for deeper investigation of the 'programme theories' championing communities' potential in better supporting their own health and well-being outcomes.

Despite the absence of large-scale, high-quality research, the UK and Global Time Banking movement continues to grow. With the support of statutory funders and third-sector umbrella organisations and consistent public health outcome frameworks, it should now be possible to capture consistent baseline data to develop a stronger evidence base for future investment.

Author statements

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Competing interests

The authors have no competing or conflicting interests.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhe.2019.11.011>.

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