

1 **Social Capital and Health: A Multilevel Cross-Lagged**
2 **Structural Equation Analysis**

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14 **Abstract:** We investigated the reciprocal relationship between individual social capital and perceived mental
15 and physical health in the UK. Using data from the British Household Panel Survey from 1991 to 2008, we
16 fitted cross-lagged structural equation models that include three indicators of social capital vis. social
17 participation, social network, and loneliness. Given that multiple measurement points (level 1) are nested
18 within individuals (level 2), we also applied a multilevel model to allow for residual variation in the outcomes
19 at the occasion and individual levels. Controlling for gender, age, employment status, educational attainment,
20 marital status, household wealth, and region, our analyses suggest that social participation predicts
21 subsequent change in perceived mental health, and vice versa. However, whilst loneliness is found to be
22 significantly related to perceived mental and physical health, reciprocal causality is not found for perceived
23 mental health. Furthermore, we find evidence for reverse effects with both perceived mental and physical
24 health appearing to be the dominant causal factor with respect to the prospective level of social network. Our
25 findings thus shed further light on the importance of social participation and social inclusion in health
26 promotion and aid the development of more effective public health policies in the UK.

27 **Key Words:** mental health, self-reported health, social capital, reciprocal influences, autoregressive cross-
28 lagged model, multilevel structural equations model
29 **JEL Classification:** J33, J41, J54.

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1 **Research Highlights**

- 2 • A reciprocal relationship exists between social capital and perceived health status
- 3 • Social participation predicts subsequent change in mental health and vice versa
- 4 • Positive perceived wellbeing helps individuals to develop a good support network
- 5 • Loneliness is significantly related to perceived mental and physical health

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1 **Main Text**

2 **1. Introduction**

3 A growing recognition of the social determinants of health suggests that social capital
4 contributes to health inequalities, both within and between populations (Henderson &
5 Whiteford, 2003). Generally, the research suggests that higher levels of social capital can
6 enhance an individual's sense of self-efficacy and mastery, reduce alienation and stress and
7 ultimately contribute to a sense of well-being, thereby improving health (Morrow, 1999).
8 There is also a consensus that social capital is important in encouraging a physically active
9 lifestyle (Booth et al., 2000; Giles-Corti & Donovan, 2002; Greiner et al., 2004; Leyden,
10 2003). Social capital might therefore provide a theoretical basis for assessing the impact of
11 community-based health promotion programs on the broader health and life of a
12 community (Baum, 2003). In particular, there is a pressing need in the UK to inform the
13 debate concerning the veracity of claims that building social capital is an important facet
14 of national health policy. Policy makers have generally accepted the importance of social
15 capital and made changes to health policy accordingly. For instance, the Allen Review, an
16 independent report presented to the UK Government, emphasises the importance of family
17 and community relationships in stimulating the physical, emotional and social development
18 of children and adolescents at key life stages (Allen, 2011). And the UK Department of
19 Health (DoH) has explicitly cited developing social capital as an important feature of health
20 promotion (DoH, 2001, 2006, 2010).

21 Previous studies highlight considerable debate over whether social capital is a feature of
22 individuals (Burt, 2009), groups (Bourdieu & Wacquant, 1992) or both (Coleman, 1988;
23 Putnam, 2001). Kawachi (2006) argues that there are two distinct concepts of social
24 capital: social cohesion and social network. The former tends to emphasize social capital
25 as a group attribute and analyses it as a contextual effect on individual health. The later
26 describes social capital in terms of the resources that are embedded within an individual's

1 social networks (Lin, 1999). An additional distinction in research on social capital is
2 between structural and cognitive dimensions (Putnam et al., 1994). The structural
3 dimension reflects the ‘quantity’ of social capital and is characterised by behavioural
4 manifestations of associational links between individuals or civic engagement. The
5 cognitive dimension is regarded as the ‘quality’ of social capital as it reflects subjective
6 attitudes such as trust in others and norms of reciprocity (Harpham et al., 2002;
7 Phongsavan et al., 2006). A number of studies have suggested that personal ties, contacts
8 and mutual support enhance an individual’s access to information, resources,
9 opportunities and public welfare policy, making available assistance and emotional
10 support and thus meeting physical and mental health needs (Muntaner, 2004; Nakhaie &
11 Arnold, 2010; Pearce & Davey Smith, 2003).

12 Folland (2008) indicates that there are three prominent theoretical ideas as to how social
13 capital may improve health: First, both physical and mental health may benefit from
14 sympathetic relationships, a trusting environment, or through the benefits of socializing.
15 Second, social capital provides information on the effectiveness of health care or health
16 behaviours. And third, increased positive social capital enhances an individual’s sense of
17 responsibility, both to one’s self and to one’s key relationships, and would be expected to
18 enhance the benefit of becoming and staying healthy.

19 Whilst international studies based on longitudinal data have generally supported a causal
20 relationship from social capital to health (Drukker et al., 2003; I. Kawachi et al., 1996;
21 Orthomer et al., 1993; Welin et al., 1992), a systematic review by Murayama et al. (2012)
22 finds that prospective evidence of the effect of social capital on health in the UK is
23 somewhat limited – only two out of nine articles. This obfuscates the relationship between
24 health outcomes and social capital and seriously impedes any attempt to identify causality.
25 For example, De Silva et al.’s (2005) systematic review of the relationship between social
26 capital and mental health concludes that there is strong evidence that mental illness could

1 result in low social capital as mentally ill individuals are more likely to appraise things
2 negatively and to withdraw socially.

3 Our aim in what follows is to investigate the temporal and directional character of the
4 relationship between individual-level social capital and perceived mental and physical
5 health using longitudinal data. Such data provide a distinct advantage over cross-sectional
6 data in the variety of sources of variability for understanding causality (Hedström &
7 Ylikoski, 2010). However, the longitudinal analyses in previous studies have been limited
8 to regression or latent growth models in which social capital is served as the criterion
9 measure. Using data from the British Household Panel Survey (BHPS) from 1991 to 2008,
10 we constructed a cross-lagged structural equation model to consider three indicators of
11 social capital and health outcomes together, making it possible to unravel the reciprocal
12 temporal relationships. Since multiple measurement points (level 1) are nested within
13 individuals (level 2), the multilevel model is specified to account for two inherent types of
14 heterogeneity – within-person across time and between-person – thereby identifying the
15 within-person variability over time from the between-person variability found in cross-
16 sectional analyses (Hoffman & Stawski, 2009).

17 The paper is set out as follows: Section 2 describes our methods in detail whilst Section 3
18 discusses our estimation and modelling. Our results are presented in Section 4 and final
19 comments are collected in Section 5.

20 **2. Methods**

21 **2.1. Data collection**

22 Our data are derived from the British Household Panel Survey (BHPS) from September
23 1991 through September 2008. The BHPS is a nationally representative panel survey of
24 the British population on a micro-social level following a sample of approximately 5,500
25 households and over 10,000 individual respondents aged 16 and over annually since 1991.

1 All original sample members are retained in the panel for as long as possible, even when
2 moving to new households. Those who join the household of a sample member are also
3 included in the survey for as long as they remain in the same household as a sample
4 member. As such, the BHPS includes detailed individual level data in a longitudinal
5 context that satisfy the basic requirement of our substantive analyses.

6 To ensure comparability over our sample period, we constructed a balanced panel in which
7 information on all the required variables is reported at each wave and in which observations
8 are limited to respondents who answer questions in each wave. The social capital indicators
9 used in our study are not measured at every wave: social participation is recorded in waves
10 1-5, 7, 9, 11, 13, 15, and 17; social network is recorded in waves 2, 4, 6, 8, 10, 12, 14, 16,
11 and 18; and loneliness is recorded in 1, 3, 5, 7, 9, 11, 13, 15, and 17. We therefore calculated
12 an average of the variables from two adjacent waves every two waves over 18 waves to
13 create values at nine measure points. For example, the value at the first measure point is
14 the average of the first and second waves in the original data. The value at the second
15 measure point is the average of the third and fourth waves, and so on. Information on
16 employment, marital status, and educational attainment was estimated using the values at
17 odd-numbered waves. Because the gap is only one year and most demographic variables
18 are highly persistent, we contend that any bias is likely to be very small. Since estimation
19 of an unbalanced panel is affected by attrition bias over time (Wooldridge, 2005), we
20 focused our analysis on a balanced sample of 3,039 individuals, implying 27,351
21 observations over the nine measure points.

22 **2.2. Measures of perceived mental health**

23 We used the responses to the General Health Questionnaire (GHQ) to measure perceived
24 mental health or psychological well-being. The BHPS uses a 12-item version of the GHQ
25 (GHQ-12) based on answers to questions on concentration, sleep loss due to worry,
26 perception of role, capability in decision making, whether constantly under strain,

1 perception of problems in overcoming difficulties, enjoyment of day-to-day activities,
2 ability to face problems, loss of confidence, self-worth, general happiness and whether
3 suffering depression. The questionnaire is usually self-administered and is based on the
4 respondent's assessment of their present psychological well-being (Bowling, 2005;
5 Williams & Goldberg, 1988). The respondents are asked to indicate on a four-point ordinal
6 scale how they have felt recently with respect to the item in question. We adopted the
7 standard GHQ dichotomous coding method (i.e. '0 0 1 1 coding') for each of the four
8 possible responses to each item, as advocated by the questionnaire's author (Williams &
9 Goldberg, 1988). Using this method, the maximum score for any respondent is therefore
10 twelve. The scoring was then reversed such that higher scores reflect an improvement in
11 mental health or a reduction in mental illness. There is no universally used threshold value
12 for GHQ-12 to identify probable self-rated mental health because the populations it is used
13 on vary considerably. We chose a threshold value of eight, as suggested by the author of
14 the questionnaire, to identify 'cases' of mental health and to create a dichotomous indicator
15 of positive or negative self-rated mental health (Williams & Goldberg, 1988). The
16 predictive and content validity of the GHQ-12 is good in comparison to other well-known
17 scaling tests of mental health (see, for example, Bowling, 2005). The GHQ-12 also
18 performs well in reliability tests and has been shown to be robust to re-testing, making it a
19 suitable longitudinal instrument (Pevalin, 2000). For instance, the reliability of the GHQ-
20 12 from 2003-2004 BHPS is of 0.89 for the dichotomous coding method (Hankins, 2007).

21 **2.3. Measures of perceived physical health**

22 The perceived physical health question in the BHPS is measured following an ordinal scale,
23 with possible responses from 'very poor', 'poor', 'fair', 'good', or 'excellent'. The
24 categories were collapsed into a dichotomous indicator by combining the 'poor' and 'very
25 poor' responses and the 'fair', 'good' and excellent' responses such that the respondent
26 was recorded as having either 'negative' or 'positive' self-rated health. Previous studies

1 have shown this measure to be one of the best predictors of healthcare utilisation, costs and
2 mortality (Bierman et al., 1999; Davies & E., 1981; Fylkesnes & Forde, 1991; Mossey &
3 Shapiro, 1982). We specified an ordered probability model in the regression analysis of
4 physical health.

5 **2.4. Measures of social capital**

6 Previous research has generally maintained that social capital is fundamentally multi-
7 dimensional with disputed and contrary definitions at both theoretical and empirical levels
8 (Cooper et al., 1999). The validity of currently available quantitative measures is keenly
9 disputable (Coulthard et al., 2001). The BHPS does however offer some reasonable
10 individual-level indicators to tackle social capital's multi-dimensionality (see David J.
11 Pevalin & Rose, 2002) - see Table 1 following. There is growing evidence of a lack of
12 correlation between indicators of social capital, in turn hinting at several pathways from
13 social capital to health (Giordano & Lindstrom, 2010; Lindström et al., 2004; Nummela et
14 al., 2008). We, therefore, simultaneously investigated a range of measures for structural
15 and cognitive social capital at the individual level and applied structural equation modelling
16 (SEM) to obtain estimates of several dimensions of social capital. SEM permits
17 measurement error to be isolated and controlled for in a way that is not possible with
18 traditional methods of aggregating data.

19 [Insert Table 1]

20 We do not consider potential contextual effects for two reasons: First, the most common
21 approach to defining social capital in research on population health to date has been the
22 social cohesion perspective (Murayama et al., 2012); and second, a systematic review of
23 social factors and health (Pickett & Pearl, 2001) and one recent multilevel study (Giordano
24 et al., 2011) demonstrate that individual-level social capital proxies have the greatest
25 influence on individual health.

1 **2.4.1. Structural social capital**

2 Structural social capital represents individual social participation and networks in the local
3 neighbourhood. Social participation is commonly referred to as a behavioural/activity
4 component of social capital and individual social capital is commonly measured by asking
5 individuals about their participation in social relationships and organisations (Bain &
6 Hicks, 1998). The social participation latent variable in this study is predicted by the
7 observed involvement in the voluntary associations listed in Table 1. The second measure,
8 ‘social network’, is that of social support from/to friends, since friends can provide an
9 important source of emotional support for adults (Adams, 1985) and the frequency of
10 contact with friends is often considered as bonding social capital (Brisson & Usher, 2007;
11 Derose, 2008; Lowndes, 2004). There is also evidence to suggest that children and
12 adolescents gain some protection against internalising behaviours, such as depression and
13 suicidal ideation, when they enjoy wider networks, either directly with their peers or
14 indirectly through their parents’ networks (Rotenberg et al., 2004). Respondents in the
15 BHPS are asked how regularly they are in touch with their three closest friends. Each item
16 uses response options of ‘no contact’, ‘less often’, ‘at least once month’, ‘at least once
17 week’, and ‘most days’, and utilises a five point scale. This three-item friendship network
18 latent variable measures overall relationship with the three closest friends in this study. As
19 Bertotti et al. (2013) find that social participation and social network are both significantly
20 associated with mental health, but the sign of correlation is of opposite direction, we used
21 these two measures separately rather than as a single structural component.

22 **2.4.2. Cognitive social capital**

23 One of the important aspects of cognitive social capital is the emotional and practical
24 support it offers in times of need. Loneliness is often viewed as a subjective measure of
25 social interaction and the antithesis to social support, highlighting the importance of social
26 perceptions and evaluations of personal relationships (Victor et al., 2000). Since the

1 literature suggests that being socially isolated can negatively affect mental as well as
2 physical health (Holt-Lunstad et al., 2010), we identified loneliness as a perceived lack of
3 social and emotional support. The BHPS includes variables indicating whether respondents
4 have someone who will listen to them, help them in a crisis, relax with them, appreciates
5 them, or comforts them. In this study these variables were coded as binary outcomes with
6 1 indicating that they have no-one and 0 otherwise.

7 **2.5. Demographic factors**

8 We used six demographic factors (age, gender, marital status, highest level of education,
9 employment status, and annual household income) in our analyses. These factors are often
10 associated with basic variations in health (Chandola, 2000; Rose & Pevalin, 2000). Current
11 annual household income was constructed from information on the annual labour and non-
12 labour income of each member of the household. To allow for the effects of household size
13 and composition, household income was equivalised using the McClements scale (see
14 Taylor et al., 1998), deflated to 2005 prices using the retail price index and transformed to
15 natural logarithms to allow for concavity between health outcomes and income. We used
16 age to remove any within-cohort age effects and also allowed for a flexible relationship
17 between health outcomes and age by specifying a cubic polynomial in age (i.e. AGE, AGE²
18 and AGE³). We included indicators for region of residence in our models but the parameter
19 estimates are not reported as geographical variation is not the focus of this paper and the
20 categories used in these variables are rather cruder. Our variables are defined in Table 2
21 following:

22 [Insert Table 2]

23 **3. Models and Estimation Methods**

24 We conducted autoregressive cross-lagged panel models (ACLPM) (Cole & Maxwell,
25 2003; Curran, 2000) to simultaneously address reciprocal influences on individual social

1 capital and health outcomes. Since multilevel structural equation model (SEM) allows for
 2 the use of latent variables to correct for measurement error, multivariate outcomes, flexible
 3 multiple group comparisons, and the calculation of overall fit statistics for model
 4 evaluation (Bovaird, 2007; Curran, 2003; Mehta & Neale, 2005), we implemented a two-
 5 level SEM approach to partition between- and within-person effects. A simultaneous
 6 equation model that allows for autoregressive effects and cross-lagged effects between
 7 health outcomes (Y_{ti}^H) and social capital (Y_{ti}^{SC}) at each measure point may be written ($t =$
 8 $2, \dots, 9$) as

$$9 \quad Y_{ti}^H = \alpha_t^H + \beta_1^H Y_{t-1,i}^H + \beta_2^H Y_{t-1,i}^{SC} + \delta^H X_{t-1,i} + \gamma^H Z_i + \mu_i^H + \varepsilon_{ti}^H \quad (1)$$

$$10 \quad Y_{ti}^{SC} = \alpha_t^{SC} + \beta_1^{SC} Y_{t-1,i}^{SC} + \beta_2^{SC} Y_{t-1,i}^H + \delta^{SC} X_{t-1,i} + \gamma^{SC} Z_i + \mu_i^{SC} + \varepsilon_{ti}^{SC} \quad (2)$$

11 where t represents an occasion, i represents an individual, α_t is a time-varying intercept
 12 term, $Y_{t-1,i}^H$ and $Y_{t-1,i}^{SC}$ are the lags of one time unit for health outcome and social capital, δ
 13 and γ are row vectors of coefficients of X_{ti} and Z_i , which are respectively a vector of
 14 control variables that vary over both individuals and time (e.g. marital status, educational
 15 attainment, household income) and a vector of control variables that vary over individuals
 16 but not over time (e.g. gender). The term μ_i denotes fixed effects that vary across
 17 individuals whilst ε_{ti} are random disturbances that are assumed to be independent of each
 18 other and normally distributed with means of zero and constant variance. We also assume
 19 that X_{ti} is strictly exogenous, meaning that it is independent of ε_{ti} . With respect to Y_{ti}^H and
 20 Y_{ti}^{SC} , we cannot assume strict exogeneity because both variables appear as dependent
 21 variables. Instead, we assume that they are sequentially exogenous (Wooldridge, 2010). β_1
 22 represents the autoregressive effects, or the effects of social capital and health outcomes
 23 on themselves measured at a later occasion. A small or zero autoregressive coefficient
 24 means that there has been a substantial reshuffling of the individual's standings on the
 25 construct over time. In contrast, a sizable autoregressive coefficient means that the

1 individual's relative standings on the construct have been relatively constant over time. β_2
2 describes cross-lagged effects that are the effects of individuals' social capital on their
3 subsequent health outcomes and the effect of health outcomes on subsequent social capital.
4 The model defined by equations 1 and 2 leads to a two-level cross-lagged analysis for the
5 individual responses with repeated measures (level 1) nested within individuals (level 2),
6 which allows for the control of unmeasured confounders and the presumption that the
7 coefficients are constant over time. The two equations are simultaneously estimated on our
8 balanced panel of data by maximum likelihood methods in generalised SEM procedure of
9 Stata v13.1 (StataCorp, Texas, USA).

10 ACLPM is specified to examine reciprocal relationships between individual social capital
11 and health outcomes over a total of nine measure points or occasions. In Figure 1 following,
12 autoregressive effects are represented as single-headed arrows running from a given
13 variable at one occasion to the same variable at the next occasion. The indicators of social
14 capital to prospectively predict health status and for health status to prospectively predict
15 social capital over an interval are illustrated by diagonal single-headed arrows. The error
16 terms associated with the indicators of social capital at follow-up are hypothesised as
17 correlated because we assumed that factors contributing to measurement error in latent
18 variables would be consistent across the two occasions.

19 **4. Results**

20 Table 3 presents descriptive statistics for all of the variables used in our analysis for the
21 analytic sample broken down by mental and physical health status. Stratifying the sample
22 by 'positive' and 'negative' reveals that individuals who rate their mental health as positive
23 tend to be younger, more likely to be male, married, employed, retired, and to have a higher
24 real household income, and to be less likely to be divorced/separated or unemployed than
25 their counterparts who rate as negative. Similarly, individuals are more likely to rate their

1 physical health as positive if they are younger, male, employed and if they have higher
2 academic qualifications and higher household income.

3 [Insert Table 3]

4 Our results in Figure 1 show that the stationary autoregressive effect of self-rated mental
5 (physical) health [0.42 (0.55), $p < 0.01$], is significant, as are the stationary autoregressive
6 effect of social capital, social participation (0.50, $p < 0.01$), social network (0.49, $p < 0.01$),
7 and loneliness (0.30, $p < 0.01$). These coefficients indicate moderate stability of mental
8 (physical) health status and social capital over occasions.

9 Net of autoregressive effects, the stationary lagged effect of social participation on
10 perceived mental health is significant (4.09, $p < 0.01$). There is also evidence of a lagged
11 effect in the opposite direction, but the magnitude is relatively small (0.016, $p < 0.01$). There
12 is some indication that lagged social network is positively related to perceived mental
13 (physical) health although neither is found to be significant. Lagged mental and physical
14 health do affect individuals' social network as 0.002 and 0.01 at the 1% level, respectively.
15 Lagged loneliness is significant and negative impacts are found on both mental (-0.05,
16 $p < 0.01$) and physical health (-0.06, $p < 0.01$). However, only lagged physical health
17 negatively affects loneliness (-0.05, $p < 0.01$), a higher physical health score at occasion $t-1$
18 is associated with a lower loneliness score at occasion t .

19 [Insert Figure 1]

20 It is apparent from Table 4 that younger and males generally present better perceived health,
21 both mental and physical. Compared to the baseline category of married/cohabiting,
22 individuals who are widowed or never married exhibit worse perceived mental health,
23 whilst only widowed respondents exhibited worse perceived physical health at the 5%
24 significance level. There is some indication that higher academic qualifications are
25 associated with better perceived mental and physical health (as compared to the baseline

1 of respondents with no qualifications). Few of the employment status categories are
2 significant. The retired and disabled are associated with worse perceived physical health,
3 and the disabled report relatively negative perceived mental health. Higher household
4 income is associated with positive perceived physical health.

5 [Insert Table 4]

6 **5. Conclusions**

7 Given that social capital plays an important and growing role in UK health policy, it is vital
8 that health enhancing intervention programs are targeted towards those population groups
9 that are in the greatest need. In most studies, these groups have been identified through
10 cross-sectional analyses that cannot exclude the possibility of reverse causality. Moreover,
11 cross-section data provides only a snap-shot of the distribution of health status at a
12 particular point in time and renders population intervention less cost-effective in terms of
13 identifying at-risk groups. Our aim in this study has been to extend prior cross-sectional
14 research and to shed further light on unidirectional and bidirectional causal relations
15 between individual-level social capital and health problems using UK panel data, thereby
16 aiding the development of more effective public health policies in the UK.

17 Our longitudinal analyses suggest that whilst there is substantial stability in both perceived
18 mental and physical health, the former exhibits lower fluctuation over time than the latter.
19 Our results further indicate that social participation strongly predicts future perceived
20 mental health, whilst simultaneous reciprocal causality occurs between them. Our results
21 are consistent with Bertotti et al. (2013) and Kawachi and Berkman (2001) who argue that
22 social participation contributes to health by providing a sense of meaning to individual's
23 lives as well as increasing access to social support. Social relationships formed by social
24 participation improve mental health by increasing the participants' fulfilment of
25 attachment, their social approval, access to resources and emotional gratification (Moen et

1 al., 1992). Therefore, social participation is important for recovery and improving the
2 health outcomes for individuals with poor mental health. For instance, a meta-analysis of
3 147 studies involving almost 100,000 individuals finds that religious involvement is also
4 associated with reduced depression, particularly for stressed populations (Smith et al.,
5 2003). Strategies to advantage communities with higher levels of social capital may include
6 individual and community empowerment (Wallerstein, 2006), community arts, and access
7 to safe, green community spaces.

8 Our study also supports previous findings that poor mental health has a detrimental impact
9 on a person's ability to participate economically and socially in social and civil activities
10 (Psychiatrists, 2009). Although in our study the estimated impact may be small in
11 magnitude, it is worth noting that exclusion from key areas of social life, such as social
12 interaction and political engagement, as well as from health service engagement results in
13 inequality, which is also a major determinant of negative mental health and a marker of
14 other risk factors (Parsonage, 2007). Interventions that use social contact or a combination
15 of social contact and education are effective at increasing awareness of poor mental health
16 in selected group and changing negative attitude in ways that will improve relationships,
17 job performance and health (Corrigan et al., 2001). Despite the paucity of evidence that
18 individual social network in preceding time periods is linked to increase perceived
19 mental/physical health at subsequent time points, our results suggest that positive perceived
20 mental and physical wellbeing helps individuals to develop a good support network. The
21 mutuality and reciprocity that occurs through social network, builds social capital, which
22 in turn is associated with well-being and resilience (McKenzie & Harpham, 2006). For
23 example, the UK Department of Health (2012) in the related Implementation Framework
24 recommends the development of peer support as one of the roles of mental health
25 organisations in implementing the strategy.

1 Our findings also support the view that loneliness has a significant negative impact upon
2 perceived mental and physical health. Cacioppo and Patrick (2008) find that loneliness
3 causes higher rises in morning levels of the stress hormone cortisol, altered gene expression
4 in immune cells, and higher blood pressure. Loneliness is also associated with an increased
5 risk of depression, sleep problems and a faster progression of Alzheimer’s disease.

6 Tackling social isolation formed the logic for much of the ‘Third Way’ policy agenda of
7 the UK Blair Labour governments (Giddens, 2013). The significant influence of mental
8 health on loneliness may provide evidence that loneliness is sometimes due to the
9 unwillingness of others to befriend the mentally ill with the stigma associated with poor
10 mental health creating a substantial barrier to socialisation (Harvey & Brophy, 2011).
11 Whilst some of the mental ill withdraw from others as a way of managing symptoms, many
12 desire more connection. For example, nearly 45% of participants in the Australian National
13 Survey of Mental Health and Wellbeing with psychosis felt they are in need of good friends
14 (Jablensky et al., 2000). It is therefore necessary to confront biased social attitudes in order
15 to reduce the discrimination and stigma of individuals who are living with poor mental
16 health.

17 There are also systematic differences in health outcomes across socio-economic groups. In
18 general, age, gender, marital status, employment status and household income are
19 significantly related to changes in both perceived mental and physical health. The analyses
20 suggest that older individuals rate their health as more negative compared to younger
21 individuals (Zack et al., 2004). Rates of positive perceived health are higher among high
22 school graduates with further education (Mikolajczyk et al., 2008; Mirowsky & Ross,
23 1998) and among males compared to females (Benyamini et al., 2003). Our study also
24 provides evidence that marriage is associated with enhanced perceived mental health
25 (Simon, 2002) and adjusted household income is associated with perceived physical health
26 (Subramanian et al., 2003).

1 This study has distinguished three indicators of social capital and their relative impacts on
2 both perceived mental and physical health. Our statistical model clearly establishes the
3 temporal relation between the two constructs and protects against the potential biasing
4 effects of reverse causation. It further allows for the differentiation of individual-specific
5 influences as well as the differentiation between time-varying and time-invariant
6 unmeasured influences on health outcomes using panel data. The estimation of these
7 individual-level and occasion-level effects renders it possible to draw valid and reliable
8 conclusions regarding the relative magnitudes of reciprocal effects of social capital and
9 health outcomes.

10 There are, however, several limitations in our data. The self-reported retrospective
11 measures for health outcomes almost certainly lead to some degree of self-reported bias.
12 In particular, self-reported bias may inflate the size of the correlation of construct across
13 time and reduce the unexplained variance available for other latent variables (Marsh, 1993).
14 A second limitation is that, similar to most panel data, the BHPS is not based on sensitive
15 designs that can provide powerful methodological possibilities to understand genetic
16 influences on personality traits leading to consistent behaviour, thoughts, and emotions
17 across situation and context (see, for example, Hahn et al., 2012; Kenrick & Funder, 1988).
18 The third limitation is that there may be potential dilution bias from regression to the
19 average values from two waves in dynamic models (Liker et al., 1985). And finally, a
20 number of commentators argue that there is more than one type of social capital. This study
21 mainly focuses on ‘individual’ (i.e. bonding) social capital – that is, horizontal tight-knit
22 ties between individuals sharing similar demographic characteristics – rather than ‘linking’
23 social capital – that is, vertical connections that span differences in power. Szreter (2002)
24 argues that the decline in linking social capital is likely to lead to an increase in health
25 inequities. Recent studies suggest that social capital can be influenced by contextual,
26 relational, and psychological attributes such as neighbourhood capacity and norms (Yu et

1 al., 2011). It is therefore important to more closely examine the contextual and individual
2 elements of social capital separately in future research.

3 **References**

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Figure Captions

Figure 1. Lags and cross-lags in multilevel equations model for social capital-health reciprocal effects at time $t-1$ and t ($n=24312$)

Tables

Table 1. Items of Social Capital

<i>Question item</i>	<i>Response/scoring</i>
<i>Social Participation</i>	
<i>Member of political party</i>	
<i>----- trade union</i>	
<i>----- environmental group</i>	
<i>----- parents association</i>	
<i>----- tenants or residents group</i>	<i>No = 0</i>
<i>----- religious group</i>	<i>Yes = 1</i>
<i>----- voluntary service group</i>	
<i>----- other community group</i>	
<i>----- other organisation</i>	
<i>Social Network</i>	
<i>How often do you see or get in touch with your 1st/2nd/3rd closest friend either by visiting, writing or by telephone</i>	<i>No contact=0; Less often = 1; At least once a month = 2; At least once a week = 3; Most days = 4</i>
<i>Loneliness</i>	
<i>Is there someone who will listen?</i>	
<i>Is there someone to help in a crisis?</i>	
<i>Is there someone you can relax with?</i>	<i>No one = 2; Yes, one person = 1; Yes, more than one person = 0</i>
<i>Anyone who really appreciates you?</i>	
<i>Anyone you can count on to offer comfort</i>	

Table 2. Variable Definitions

<i>MENTAL HEALTH</i>	<i>Continuous score, range from 0 to 12 (the higher, the better)</i>
<i>PHYSICAL HEALTH</i>	<i>Ordinal scale, range from 1 to 5 (the higher, the better)</i>
<i>AGE</i>	<i>Age in years at 1st December of current time point</i>
<i>FEMALE</i>	<i>1 if female, 0 otherwise (reference group)</i>
<i>MALE</i>	<i>1 if male, 0 otherwise</i>
<i>MARRIED</i>	<i>1 if married or living as a couple, 0 otherwise (reference group)</i>
<i>SEPARATED</i>	<i>1 if divorced or separated, 0 otherwise</i>
<i>WIDOW</i>	<i>1 if widowed, 0 otherwise</i>
<i>NEVER MARRIED</i>	<i>1 if never married, 0 otherwise</i>
<i>WITHOUT QUALIFICATION</i>	<i>1 if no qualification, 0 otherwise (reference group)</i>
<i>WITH QUALIFICATION</i>	<i>1 if qualification, 0 otherwise</i>
<i>WITH HIGHER QUALIFICATION</i>	<i>1 if higher degree, 0 otherwise</i>
<i>PAID EMPLOYMENT</i>	<i>1 if in paid employed, 0 otherwise (reference group)</i>
<i>SELF EMPLOYMENT</i>	<i>1 if self-employed, 0 otherwise</i>
<i>UNEMPLOYMENT</i>	<i>1 if unemployed, 0 otherwise</i>
<i>RETIRED</i>	<i>1 if retired, 0 otherwise</i>
<i>STUDENT</i>	<i>1 if full-time student, 0 otherwise</i>
<i>OTHER EMPLOYMENT</i>	<i>1 if other employment status, 0 otherwise</i>
<i>LOG (HOUSEHOLD INCOME)</i>	<i>Natural log of equivalised annual real household income in pounds</i>

Table 3. Variable Means by Health Indicators

	<i>Self-rated Mental Health</i>		<i>Self-rated Physical Health</i>	
	<i>Positive</i> <i>N = 19648</i>	<i>Negative</i> <i>N = 4664</i>	<i>Positive</i> <i>N = 22462</i>	<i>Negative</i> <i>N = 1850</i>
<i>AGE</i>	45.84	47.06	47.11	50.65
<i>FEMALE</i>	0.566	0.671	0.579	0.661
<i>MALE</i>	0.434	0.329	0.421	0.339
<i>MARRIED</i>	0.701	0.644	0.690	0.657
<i>SEPARATED</i>	0.094	0.151	0.099	0.165
<i>WIDOW</i>	0.047	0.048	0.051	0.064
<i>NEVER MARRIED</i>	0.156	0.157	0.160	0.114
<i>WITHOUT QUALIFICATION</i>	0.175	0.182	0.178	0.316
<i>WITH QUALIFICATION</i>	0.408	0.393	0.397	0.386
<i>WITH HIGHER QUALIFICATION</i>	0.422	0.414	0.421	0.295
<i>PAID EMPLOYMENT</i>	0.602	0.553	0.602	0.341
<i>SELF EMPLOYMENT</i>	0.085	0.072	0.084	0.045
<i>UN EMPLOYMENT</i>	0.019	0.039	0.022	0.030
<i>RETIRED</i>	0.175	0.143	0.177	0.250
<i>STUDENT</i>	0.011	0.010	0.010	0.012
<i>OTHER EMPLOYMENT</i>	0.013	0.010	0.009	0.010
<i>LOG (HOUSEHOLD INCOME)</i>	10.148	10.085	10.146	9.855

Table 4. Estimated Coefficients from Multilevel Cross-Lagged Model

	<i>Self-rated Mental Health</i>		<i>Self-rated</i>	
	<i>Coef.</i>	<i>S.E.</i>	<i>Coef.</i>	<i>S.E.</i>
<i>AGE</i>	-0.052 ***	0.016	-0.024**	0.012
<i>AGE2</i>	0.148***	0.034	0.040*	0.024
<i>AGE3</i>	-0.011***	0.002	-0.003**	0.002
<i>MALE</i>	0.374***	0.022	0.106**	0.042
<i>SEPARATED</i>	-0.091*	0.049	-0.009	0.039
<i>WIDOW</i>	-0.273***	0.069	-0.113**	0.056
<i>NEVER MARRIED</i>	-0.173***	0.051	0.006	0.045
<i>WITH QUALIFICATION</i>	0.159***	0.047	0.210***	0.059
<i>WITH HIGHER QUALIFICATION</i>	0.130***	0.048	0.268***	0.066
<i>SELF EMPLOYMENT</i>	0.018	0.050	0.053	0.038
<i>UN EMPLOYMENT</i>	0.117	0.079	0.097*	0.055
<i>RETIRED</i>	0.067	0.050	-0.078**	0.037
<i>STUDENT</i>	0.150*	0.090	-0.078	0.060
<i>OTHER EMPLOYMENT</i>	0.046	0.060	-0.047	0.045
<i>LOG (HOUSEHOLD INCOME)</i>	0.007	0.022	0.054***	0.018

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Time dummies and geographic covariates have been suppressed from results

Figures

Figure 1. Lags and cross-lags in multilevel equations model for social capital-health reciprocal effects at time t-1 and t (n=24312)

