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Structural Analysis of Influences on Workplace Productivity Loss

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Abstract:
This study investigates systematically and simultaneously a wide range of influences on workplace productivity loss. Workplace productivity has been widely discussed in literature for many years, yet most of the existing studies focus on a narrow pathway of effects; this can potentially result in overestimating the examined influences due to capturing unobserved effects of omitted variables. In this study we examine various productivity determinants (workers' characteristics, lifestyle, commuting, health and wellbeing, and job and workplace environment) in a single combined model, after investigating their interrelations, to re-assess some of the previous findings and provide new insights into the subject. This is made possible through utilising a unique and extensive dataset of nearly 30,000 employees in the UK collected in 2017 and developing a comprehensive Structural Equation Model (SEM). Our results generally confirm the previous findings but also highlight the necessity to consider a broad range of factors as some of the initially strong influences (e.g. of work engagement) become statistically insignificant once additional variables are introduced into the model. Overall, personal characteristics, particularly physical and mental health, as well as job characteristics such as stress at work explain most of the variance in productivity loss, while lifestyle or working patterns are less important.

JEL Classification: C38, J24
Keywords: SEM, productivity, absenteeism, presenteeism

1 Introduction

Understanding factors behind employee productivity and performance at the workplace has been a goal of academics and organisations alike for decades. Initially, the main research focus was on *absenteeism*, generally defined as not showing up for work, due to its evident implications for performance of organisations and relative ease of measurement (Johns, 2010). However, more recently *presenteeism* has been gaining attention as it is suggested to cause higher aggregate productivity loss than absenteeism (see e.g. Collins et al., 2005, or Parsonage, 2007). Presenteeism has been defined in different ways in the literature, most often as being present at work but being limited in some aspects of job performance by a health problem and thus experiencing decreased productivity and below-normal work quality (Hutting, Engels, Heerkens, Staal, & Nijhuis-Van der Sanden, 2014, Braakman-Jansen, Taal, Kuper, & van de Laar, 2011).

A multitude of factors has been suggested and empirically tested to be determinants of productivity loss measured by absenteeism and presenteeism, including physical and mental health (Zelenski, Murphy, & Jenkins, 2008, Alonso et al., 2011), lifestyle (Wolf et al., 2009), personal and family factors (Johns, 2011), relationships (Hansen & Andersen, 2008), work strain (Darr & Johns, 2008) or job and workplace characteristics (Kuoppala, Lamminpää, Liira, & Vainio, 2008). However, due to methodological and/or data limitations, the studies often consider only a relatively narrow pathway of effects and largely ignore interrelations between the individual influences. Focusing on a small set of variables may conflate together various separate, though often correlated, effects and hence fail to capture the main underlying explanations. It therefore is unclear whether the suggested relationships would remain as strong, or even detectable, when other factors are considered.

The present study aims to shed light on this important research gap and provides new insights into the complex framework of employees' productivity determinants and their relative importance through modelling an extensive set of factors simultaneously. It utilises a unique, extensive cross-sectional dataset covering 29,928 employees from the UK collected through the Britain's Healthiest Workplace[1] competition in 2017. The relationships are tested in an advanced Structural Equation Model (SEM) which combines the analysis of predefined direct and indirect influences (i.e. path analysis) with factor analysis – a technique to reduce the dimensionality of highly correlated variables into lower dimensional latent space.

More specifically, first we construct a set of productivity models for each of personal, job-related, and workplace influences in line with what is suggested in the previous literature. This is done through

[1] Britain's Healthiest Workplace is an annual online survey of organisations and their employees in the UK commissioned by VitalityHealth. See Section 4 for more information.

estimation of continuous latent variables for each model and testing interrelations within the models. Estimation of the simple models allows us to compare our results with the prior studies and assess the baseline links between variables. Second, we combine all partial models into a combined SEM to evaluate the relative importance and the path structure of influences on productivity. Comparing the direct, indirect and combined influences on workplace productivity across the individual models we can make inferences about the extent to which narrow-focused models are affected by the omitted-variable bias.

After a brief review of literature and explanation of data and method of study in Sections 2 to 4, we conduct exploratory and confirmatory factor analysis in Sections 5 and 6, followed by structural modelling in Section 7. Finally, Sections 8 and 9 provide additional discussion about the results and conclude the study.

2 Existing research

Employee productivity at the workplace is a measure encompassing both efficiency (time or other resources required for completing a task) and effectiveness (the degree to which objectives are achieved and/or targeted problems are solved). It is an element of broader employee performance: the aggregated value to the organisation of the discrete behavioural episodes that an individual performs over a standard interval of time (Motowildo, Borman, & Schmit, 1997). Productivity can measured using an output measure, such as volume of production or number of customers served per unit of time or resources, and may take into account quality of the output. However, the particular definition of employee productivity depends on organisational and job's characteristics. Given the numerous definitions of productivity and dependence of absolute productivity measurement on the particular workplace settings, research focus is often on relative productivity loss, i.e. comparison of individual's performance to an optimal or past performance levels or to that of other employees (see e.g. Anitha, 2014, or Ford, Cerasoli, Higgins, & Decesare, 2011). One common way to evaluate productivity loss is through absenteeism and presenteeism – i.e. the share of time that an employee did not work or worked with a limited efficiency when compared to their contract or expectations.

Many studies have been written on the topic of productivity and determinants of absenteeism and presenteeism. Below we discuss the most common individual and organisational factors associated with the two concepts.

Physical and mental well-being, lifestyle

The World Health Organisation defines health as a complete state of physical, mental and social well-being (World Health Organisation, 1946). According to the definition, health assessment includes factors such as diseases, biometric indicators, life satisfaction, anxiety, depression or fatigue, and is substantially affected by one's lifestyle, e.g. sleeping patterns, alcohol use, smoking or wellness behaviours. On the other hand, one's lifestyle depends on their health; this inherently creates two layers of effects in which both health and lifestyle affect productivity but also each other.

A large body of literature has shown the importance of health as workplace productivity determinant using a range of indicators. Some of the studies showing the negative effects of poor physical health include Gates, Succop, Brehm, Gillespie, and Sommers (2008) and Lal, Moodie, Ashton, Siahpush, and Swinburn (2012) who analyse obesity; Hex, Bartlett, Wright, Taylor, and Varley (2012) and Tunceli et al. (2005) who look specifically at individuals with diabetes; or Hedge and Ray (2004) and Martimo et al. (2009) who target musculoskeletal conditions. Analysing absenteeism and presenteeism associated with ten major health conditions, Goetzel et al. (2004) then estimate that presenteeism costs are higher than medical costs in most cases and represent 18% to 60% of all costs for the ten examined conditions.

Similarly, a number of mental health indicators have been used as productivity determinants. For instance, Merrill et al. (2012) show the importance of personal problems, financial concerns and depression, while Boles, Pelletier, and Lynch (2004), Tarafdar, Tu, Ragu-Nathan, and Ragu-Nathan (2007) or Zelenski et al. (2008) found positive correlation between indicators of happiness and productivity. Quantifying productivity losses due to impaired mental well-being on a sample of more than 60,000 full-time employees, Hilton, Scuffham, Vecchio, and Whiteford (2010) show that productivity losses increase with the severity of mental health issues. Specifically, employees with high levels of psychological distress had three times higher productivity losses than those with mild levels of distress.

Finally, influences of lifestyle indicators on absenteeism and presenteeism have then been evaluated e.g. by Brown, Gilson, Burton, and Brown (2011), who look at physical activity and psycho-social health; Bouchery, Harwood, Sacks, Simon, and Brewer (2011) and Frone (2006), who look at the burden of alcohol consumption; or Rosekind et al. (2010) and Hafner, Stepanek, Taylor, Troxel, and Van Stolk (2016), who estimate the impact of insufficient sleep. All of the risk factors have been shown to have statistically significant effect on productivity.

Job attitude and characteristics

Job attitude is set of feelings toward, beliefs about, and attachment to one's job. Research shows

that it is mainly determined by job characteristics (Jex & Britt, 2014), i.e. factors such as job autonomy or feedback. Such factors are generally determined by specifics of one's job and are only partially within control of an individual, as opposed to many of the physical, mental and lifestyle factors. However, job attitude may also be affected by worker characteristics or emotional moods (Judge & Kammeyer-Mueller, 2012). The determinants of job attitudes have been studied e.g. by Hakanen, Bakker, & Demerouti, 2005; Bakker, Hakanen, Demerouti, & Xanthopoulou, 2007; or Akhtar, Boustani, Tsivrikos, & Chamorro-Premuzic, 2015).

Job attitude can be measured e.g. by job satisfaction or employee engagement, which are usually highly correlated with each other. Work engagement can be defined as the level of commitment and involvement an employee has towards their organisation and its values (Anitha, 2014). It has received a particular attention in the empirical literature (see e.g. Xanthopoulou, Bakker, Demerouti, & Schaufeli, 2009; Demerouti & Cropanzano, 2010; Salanova, Agut, & Peiró, 2005; or Rongen, Robroek, Schaufeli, & Burdorf, 2014) and has been shown to have strong causal influence on workplace productivity. However, as we discuss further in our study, this may be partially due to omission of other relevant factors in the analysis. The strong influence of job satisfaction and other job characteristics, such as work-related stress, on productivity has been shown e.g. by Judge and Kammeyer-Mueller (2008), Judge and Kammeyer-Mueller (2012), AbuAlRub (2004) or Staufenbiel and König (2010).

Workplace characteristics

Workplace and organisational characteristics represent the broader attitude of an employer and its management towards its employees. Examples include company values, support from management, wellbeing offer, fairness in treatment and appraisal or open and honest communication. Again, such factors are generally beyond individual's control although they may be affected by attitude towards job and workplace.

The influence of workplace and organisational factors have been investigated e.g. by Lewis and Malecha (2011), Patterson et al. (2005), Shanock and Eisenberger (2006), Kuoppala et al. (2008) or Pereira, Coombes, Comans, and Johnston (2015). Kuoppala et al. (2008) consider links between leadership, wellbeing at work, work-related health and work-related loss of productivity, suggesting that poor leadership has negative consequences for productivity. Similarly, Pereira et al. (2015) provide a systematic literature review investigating the effect of onsite workplace health and well-being interventions on employee productivity, showing that organisations with better wellbeing offer see lower productivity losses.

3 Analytical approach

Due to data and/or methodological limitations, many of the empirical studies presented in the literature review focus on a limited number of influences. However, a robust analysis of workplace productivity determinants requires comprehensive, systematic data on a wide range of explanatory variables in order to properly identify the complex network of effects and avoid misinterpretation of results that may in fact capture other, unidentified effects. In addition, it requires an analytical approach able to overcome the problem of endogeneity by controlling for high-dimensional and highly interrelated influences.

We develop a novel, integrated Structural Equation Models (SEMs) to estimate the influences of physical and mental health, lifestyle, personal and family factors, and job and workplace characteristics on workplace productivity. This general-purpose method provides a systematic decomposition of the influences on workplace productivity, where the effects of each variable can be examined in turn. The pathways of influences are both direct and indirect (mediated through other variables), creating a complex net of effects on productivity.

SEM is a theory-driven data analytical approach for evaluation of *a priory* specified hypotheses about causal relations among measured and/or latent variables (Jahanshahi, Jin, & Williams, 2015; Mueller, Hancock, et al., 2010). SEM has several advantages over standard path analysis and multiple regression; in particular, it provides adequate tests of the effects after adjustments for unreliability of the measures and takes into account the inter-relationships among independent variables (Litwin & Shiovitz-Ezra, 2006). It also combines structural analysis with confirmatory factor analysis, allowing reduction of dimensionality of highly correlated indicators into a lower dimensional latent space, i.e. one or more latent variables. This is particularly useful in the context of productivity determinants as the individual indicators can be grouped into distinct latent constructs which cannot be measured directly, such as "lifestyle", "mental health" and "physical health".

SEM framework can be split into two components – a measurement model (also called confirmatory factor analysis, CFA) and a structural model – and is often preceded by exploratory factor analysis (EFA), which is used to investigate the number and form of latent variables (factors), i.e. how latent variables are manifested into the observed data space. Specifically, building upon findings from EFA, measurement model represents links between high dimensional observed indicators and unobserved or latent factors. Structural model then specifies causal links between both the sets of constructed factors and the directly observed variables.

Correspondingly, in what follows we first employ factor analysis to construct a set of factors

(latent variables) measuring the conceptual elements determined in the prior literature. Following the structure of the literature review section, we distinguish personal, job, and workplace models and allocate the factors (e.g. mental health or job attitudes) to them accordingly. Secondly, we test influences of the newly created variables, as well as other standalone indicators that would not fit in any of the factors, in a set of separate SEM frameworks, each representing one of the three models. The SEM's utilise both the measurement model, representing the constructed factors and their linkage to the observed indicators, and the structural model, which defines (causal) links within the final set of variables used in the framework. The individual models allow us to observe the estimated influences in isolation, similarly to the previous studies. Finally, we combine the individual models in a single overarching SEM framework in order to analyse changes in the estimated influences as a result of additional variables being considered.

The theoretical foundations of our model are based on Bakker and Demerouti (2008), Anitha (2014) and Miraglia and Johns (2016), who also construct various individual- or workplace-related latent variables from a set of observable indicators and analyse their influences in a SEM framework. Specifically, Miraglia and Johns (2016) suggest that personal resources, job demands and job resources are all independently and exogenously determined and affect employee's health and job attitudes, which subsequently affect (both directly and indirectly – through mediation factors) absenteeism and presenteeism.

4 Data

We use data collected through the 2017 Britain's Healthiest Workplace survey of organisations and their employees in the UK. The survey is open to all organisations in the UK with more than 20 employees from any industrial sector; participating organisations self-select to the survey and distribute the survey links to their employees. There is no fee for participation nor a selection process for participants. All employees aged 18+ are allowed to complete the survey, yet their participation is voluntary and results are anonymised. The survey covers personal, social, lifestyle, job and workplace areas. Since its inception in 2013, more than 370 organisations and 124,000 individual employees participated in the study.

Our data consist of the entire 2017 cross-sectional dataset of 31,950 employee responses across all 173 participating organisations. Unfortunately, the participation rates per organisation are unknown as the full lists of eligible employees were not disclosed. Given that our results may be affected by a self-selection bias since we cannot control for the employee and employer participation, we compared

Table 1: List and categorisation of variables used in the analysis

Model	Category	Variable	Scale
Personal	*Lifestyle*	Physical exercise	Minutes per week
		Consumption of fruits and vegetables	Portions per day
		Consumption of dietary fats and oils	Portions per day
		Consumption of trans-unsaturated fatty acids	Portions per day
		Consumption of low-fat dairy products	Portions per day
		Alcohol consumption	Units per week[a]
		Smoking	Smoker/Nonsmoker
		Sleep length	Hours per day
	Mental health	Self-assessment of mental health	Poor-Excellent
		Kessler Psychological Distress Scale (K6)[b]	0-24[a]
		Life satisfaction	0-10
		Financial concerns	A lot; A little; None
	Physical health	Self-assessment of physical health	Poor-Excellent
		BMI	kg/m^2 [a]
		Number of musculoskeletal health conditions	0-9[a]
		Inability to work due to musculoskeletal health	Yes/No
		Number of chronic conditions	0-16[a]
		Fatigue	Always-Never
Job	*Job characteristics*	Job satisfaction	0-10
		Level of work-related stress[b]	0-7[a]
		Isolation at workplace	Always-Never
		Safety at workplace	Never-Always
	Work patterns	Possibility to work from home	No/Yes
		Possibility to work flexible hours	No/Yes
		Work commuting time	Minutes per day (one way)[a]
Workplace	*Support from organisation*	Support to be physically active	Disagree-Agree
		Support to eat healthy diet	Disagree-Agree
		Support to live tobacco free	Disagree-Agree
		Support to manage stress at work	Disagree-Agree
		Support when unwell	Disagree-Agree
		Importance of health and wellbeing	Disagree-Agree
	Support from *managers*	Manager cares about wellbeing	Disagree-Agree
		Manager is encouraging	Disagree-Agree
		Openness to discuss mental health problems	Disagree-Agree
All		Work engagement[b]	0-6 (continuous)
		Productivity[b]	0%-100%

Notes: For all variables, higher values represent preferable outcomes. For individuals with no self-reported absenteeism and presenteeism, the productivity estimate is at 100%.

[a] Converted to a positive scale; all values subtracted from the theoretical maximum or the highest observed value.

[b] Composite index, refer to Table A3 for more information.

characteristics of the survey respondents to a representative sample of the working population in the UK using data from the Health Survey for England (2016)[2] across a multitude of variables, including age, gender, ethnicity or bmi. The results, presented in Tables A7 and A8, show that both samples are similar in their characteristics and estimated influences are directionally equivalent. Specifically, estimating an equivalent regression with life satisfaction as the dependent variable using both samples, the coefficients of other factors are close in value and statistical significance. The only exception is ethnic structure; our dataset contains 10 pp more white individuals and proportionally less black, Asian and mixed ethnicities. Consequently, white ethnicity appears as a statistically significant variable in the test regression using the study dataset and as non-significant in the representative dataset (although with a positive coefficient in both cases). Given that ethnicity rarely appears as a statistically significant variable in the main results (see below), we argue that the outcomes are applicable to the general working population.

A separate potential issue with the self-reported character of many variables in our dataset is that some of them may be consistently under- or over-stated. To control for such systematic measurement errors, we estimated correlation among error terms during the exploratory factor analysis and, where statistically significant, we included the explicit correlation structure in the final latent variable estimation. Note that the opposite issue of non-systematic measurement errors is controlled using latent variables, which capture communality across correlated indicators.

After excluding responses with missing values, the final dataset consists of 29,928 responses. With more than 90 indicators in the original dataset, each variable was carefully considered for inclusion in the study dataset based on intuition and appearance in the prior literature, eventually limiting the number of included variables to 36. In line with discussion presented in Section 2, we can broadly categorise the resulting dataset into variables linked principally to an individual, a particular workplace or an organisation as a whole, and adapt this intuition in designing the individual models presented in the next section. Indeed, each of the models thus represents a coherent framework of factors that are intuitively related to each other (e.g. diet, alcohol consumption, smoking and sleep patterns; or job satisfaction and stress, isolation and safety at the workplace) and have been proven interlinked in the previous studies.

The full list of variables used in this study is presented in Table 1 with their descriptive statistics reported in Table A1 and Table A2 in the Appendix. Most of the variables represent a single question in the survey, while several variables represent composite indices created and validated in the prior literature. For instance, mental wellbeing is measured using the Kessler Psychological Distress Scale

[2] UK Government Statistical Service (2016).

(Kessler et al., 2002) whereas work engagement is measured using the Utrecht Work Engagement Scale (Schaufeli, Bakker, & Salanova, 2006). The list of composite variables and their structure is shown in Table A3.

In order to simplify interpretation of results, we reordered some of the variables so that for all variables higher values represent the preferable outcomes. For instance, the question on feeling isolated at workplace, originally on a 0 - never to 4 - always scale was transformed to 0 - always to 4 - never scale (see Table 1 for details). Productivity is measured relative to the maximum potential individual performance at the workplace and is reported on a [0; 100%] scale, where 100% equals maximum productivity and lower values represent presence of self-reported absenteeism and/or presenteeism. The analysis was done in Stata 15 (StataCorp., 2017).

5 Factor analysis

Given the large number of indicators conceptually related to a few individual and workplace themes, it is unsurprising that many of the selected variables are highly inter-correlated (refer to the Pearson correlation coefficient matrix shown in Table A6 in the Appendix). Hence, they cannot be treated as independent explanatory variables. EFA turns such a problem into an advantage, investigating associations among variables and possibilities to create variable clusters defining a composite, latent variable that is better capable of representing the pattern of influences than any of the constituents (Jahanshahi et al., 2015). In other words, EFA reveals the extent to which variance of input variables is caused by underlying common factors. As such, EFA is a first step in the factor analysis, used to determine the optimal number and structure of factors. It is then followed by CFA, which estimates the individual factor scores that can be later used in the SEM framework instead of individual indicators, reducing dimensionality of the model.

For the *personal* model covering physical and mental wellbeing and lifestyle, the preliminary EFA (see Table A5) was done within the three subcategories (mental health, physical health and lifestyle) using the relevant variables. Based on the results, each subcategory is best represented by one factor; we name them *mental health*, *physical health*, and *lifestyle* accordingly.

In order to find latent structure with the best fit to the observed data, CFA is done iteratively (see Table 2). We start with a simple model with no covariance structure corresponding to the EFA output and subsequently move towards more complex models. In each step, the Comparative Fit Index (CFI) and difference in the χ^2 statistic in relation to difference in the number of degrees of freedom is used to assess suitability of the model (Hoyle, 1995).

Table 2: Personal model - standardised factor loadings and statistics

Latent constructs and indicators	Model 1	Model 2	Model 3
	Factor loadings		
Mental health			
Mental health self-assessment	0.783	0.655	-
Kessler scale (K6)	0.818	0.684	-
Life satisfaction	0.683	0.802	-
Financial concerns	0.418	0.464	-
Covariance: MH SA–Kessler scale	-	0.369	-
CFI	0.978	0.997	-
Physical health			
Physical health self-assessment	0.628	0.529	0.455
BMI	0.390	0.248	0.199
Fatigue	0.427	0.469	0.446
# chronic conditions	0.440	0.433	0.372
# musculoskeletal health conditions	0.488	0.551	0.617
Inability to work due to MSK cond.	0.399	0.436	0.448
Covariance: PH SA–BMI	-	0.269	0.302
Covariance: PH SA–# MSK	-	-	-0.032
Covariance: PH SA–fatigue	-	-	0.090
Covariance: PH SA–# chronic c.	-	-	0.130
Covariance: BMI–# chronic c.	-	-	0.118
CFI	0.875	0.959	0.995
Lifestyle			
Physical activity	0.306	0.303	0.217
Fruits and vegetables	0.462	0.460	0.391
Dietary fats and oils	0.392	0.389	0.423
Trans-unsaturated fatty acids	0.448	0.453	0.482
Low-fat dairy products	0.290	0.296	0.315
Smoking	0.069	-	-
Alcohol consumption	0.039	-	-
Sleep length	0.118	-	-
Covariance: exercise–fruits	-	-	0.134
CFI	-	0.910	0.970
Sample size	29,928	29,928	29,928

PH SA = Physical activity self-assessment, CFI = Comparative fit index.
For all variables, higher values represent preferable outcomes.

The optimal factor representation is as follows. Mental health consists of four endogenous variables: mental health self-assessment, Kessler Psychological Distress Scale, life satisfaction, and measure of financial concerns. Similarly, physical health is measured using an overall physical health self-assessment, BMI, assessment of fatigue, number of existing chronic and musculoskeletal (MSK) health conditions, and whether the existing MSK conditions affected one's work. In both cases, we explicitly estimate additional covariance structure among the variables.

On the contrary, given that the lifestyle variables are nearly uncorrelated, some of them (smoking, alcohol consumption and sleep length) are unfit to serve as factors in relation to a latent variable (Tabachnick & Fidell, 2007), which is also evident from the low factor loadings. The three variables are therefore considered separately in the following analysis, while the lifestyle factor is measured using four dietary indicators (amount of fruits and vegetables, dietary fats and oils, trans-unsaturated fatty acids, and low-fat as opposed to high-fat dairy products) and amount of physical exercise. Interestingly, this shows that more active people also tend to have healthy diet, but there appears to be no link to how much they smoke, drink or sleep.

The *job* model is considerably simpler than the personal model as it considers only two factor variables determined through initial EHA and one individual explanatory variable, which would not fit in the factors (see Table A5). Unlike in the personal model where all variables associated with one factor shows low or negative factor loadings for other factors, the distinction is less clear in the job model as flexible hours and work from home have factor loadings of 0.28 also in the job characteristics pattern. The two factors are thus estimated simultaneously with explicitly assumed covariance between them. Again, CFA is done iteratively, with the first model considering only covariance between the factors and the further models adding covariance between the measured variables. The CFA output is shown in Table 3.

We name the two resulting factors are *job characteristics* and *work patterns*. Job characteristics consist of job satisfaction, a composite measure of work-related stress, and feeling isolated and safe at the workplace. Work patterns consist of possibility to work flexible hours and work from home. Commuting time to work is considered a separate variable.

Lastly, let us consider the *workplace* model. As described in Table A1, there are three distinct variables capturing willingness to discuss mental health problems: with line manager, HR representative, and colleague. The variables are highly correlated (Spearman's rank correlation coefficients are all above 54%), suggesting that willingness to discuss mental health is determined jointly, reflecting both general organisation culture and personal attitude towards discussing problems. Hence, factor analysis within the Workplace category is done in two steps, with the three variables being collapsed

Table 3: Job model – standardised factor loadings

Latent constructs and indicators	Model 1	Model 2	Model 3
	Factor loadings		
Job characteristics			
Job satisfaction	0.711	0.713	0.713
Level of work-related stress	0.738	0.744	0.744
Isolation at workplace	0.570	0.558	0.558
Safety at workplace	0.383	0.361	0.360
Work patterns			
Possibility to work flexible hours	0.509	0.588	0.586
Possibility to work from home	0.714	0.605	0.606
Commuting time	-0.138	0.063	-
Covariances: Job characteristics–Work patterns	0.283	0.338	0.340
Isolation–Safety	-	0.103	0.103
Isolation–Work from home	-	-0.121	-0.129
Commuting time–Flexible hours	-	-0.051	-
Commuting time–Work from home	-	-0.219	-
CFI	0.949	0.984	0.985
Sample size	29,928	29,928	29,928

CFI = Comparative fit index. For all variables, higher values represent preferable outcomes.

in a single factor – openness to discussion about mental health – which subsequently forms part of the broader factors. The process is shown in Table A5 (EFA) and Table 4 (CFA).

According to EFA the data should be represented using two factors; we name them *support from organisation* and *support from managers*. However, due to the previously discussed high correlation among variables in the model, factor loadings for support from organisation are higher than 0.4 for all of the variables and differ more substantially only for support from managers. The factors are therefore again estimated simultaneously. Support from organisation consists of feeling that employee wellbeing is important for the organisation and feeling supported in physical activity, diet, smoking, stress, and when unwell. Support from managers consists of openness to discuss mental health issues, being encouraged by managers at work, and feeling that managers care about one's wellbeing.

6 Partial models of workplace productivity

Using factor analysis we reduced dimensionality of the model for analysis from 44 variables to 19 (consisting of 7 factors and 12 observed variables, 6 of which are controls - age, gender, ethnicity, education, income and job position). In the following two sections we analyse the pathways between the remaining variables. First, in this section, we develop three separate models of workplace productivity, broadly based on those estimated in the presented prior literature. In the following

Table 4: Workplace model – standardised factor loadings

Latent constructs and indicators	Model 1	Model 2	Model 3
	Factor loadings		
Openness to discussion about mental health			
Discussion with line manager	0.841	-	-
Discussion with HR representative	0.781	-	-
Discussion with colleague	0.695	-	-
Support from organisation			
Support - physical activity	-	0.769	0.640
Support - diet	-	0.798	0.659
Support - smoking	-	0.644	0.553
Support - stress	-	0.749	0.830
Support - when unwell	-	0.581	0.628
Wellbeing importance for the organisation	-	0.533	0.565
Support from managers			
Openness to discussion about mental health	-	0.446	0.578
Manager encouragement	-	0.833	0.609
Manager wellbeing	-	0.906	0.667
Covariances: Organisation support–Manager support	-	0.515	0.739
Support PA–Support diet	-		0.471
Support PA–Support smoking	-	-	0.220
Support diet–Support smoking	-	-	0.320
Support diet–Support unwell	-	-	-0.012
Support stress–Support unwell	-	-	0.028
Support unwell–Manager encouragement	-	-	0.143
Support unwell–Manager wellbeing	-	-	0.251
Man. encouragement–Man. wellbeing	-	-	0.595
CFI	-	0.914	0.992
Sample size	29,928	29,928	29,928

CFI = Comparative fit index. For all variables, higher values represent positive outcomes.

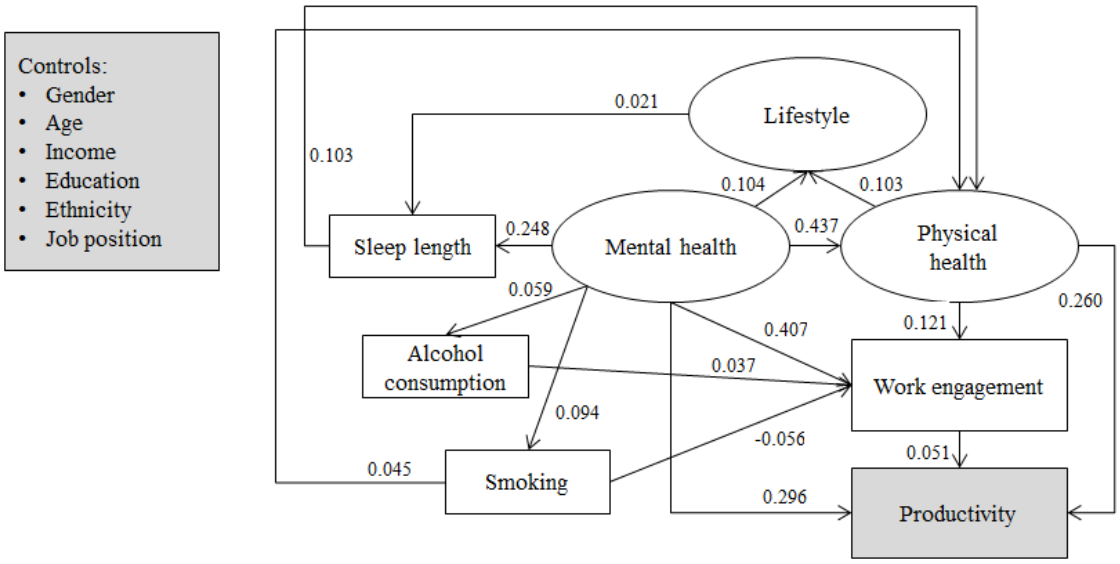
section we then combine the three models into a single framework, in order to account for potential interrelations.

For each individual model, we test various SEM structures with different directions of influences, looking for a structure with the best fit to the data. The Akaike and Bayesian information criterion (AIC and BIC) are used to determine model fit. The statistically significant influences (within the 0.01 confidence interval) in the optimal models are illustrated by path diagrams. Note that the diagrams in the main text show only the factors and individual variables determined through the factor analysis. The full models, including the observed variables forming the broader factors, are shown in the Appendix.

6.1 Personal model - physical and mental wellbeing, lifestyle

The path analysis for the *personal* model is depicted in Figure 1, with the full list of direct and indirect effects provided in Table 6. We can see that mental health has the strongest direct and indirect influence on workplace productivity (with the standardised coefficients of 0.296 and 0.145, respectively). 86% of the total indirect influences is through the physical health which is largely dependent on mental health (with the coefficient of 0.260). The link between physical health and productivity is also strong and partially mediated through work engagement. Influence of the other factors is negligible, with only engagement having statistically significant, although rather low, direct effect on productivity.

Figure 1: Personal model.



Notes: The diagram represents model that fits the observed data the best. Only paths with direct or indirect effect on productivity are shown with standardised coefficients. All the paths shown are statistically significant at the <0.001 level.

To compare our results with the findings from previous literature on the influence of work engagement on productivity, we develop a model in which only work engagement is considered an explanatory variable of productivity in addition to the full set of controls (i.e. the effect of lifestyle, mental health and physical health are disregarded). The estimated standardised coefficient of 0.267 for the influence of work engagement on productivity (see Table 5) is in line with what was reported in the previous studies (refer e.g. to Demerouti & Cropanzano, 2010, Salanova et al., 2005 or Xanthopoulou et al., 2009). Note that when we include lifestyle and health variables in the model, as shown in Figure 1, the influence of work engagement becomes negligible, suggesting that mental and physical health are in fact the major influences behind productivity loss and it is their effect that is captured by work engagement when they are excluded from the model. This finding highlights the importance of wider consideration of variables to tackle the potential issue of omitted-variable bias.

Table 5: Results of a SEM model with work engagement and controls only. Explained variable: productivity.

Variable	Std. Coef.
Work engagement	0.267***
Gender - Male	0.074***
Age	0.066***
Education - First cycle of secondary	0.046
Education - Second cycle of secondary	0.034
Education - Post-secondary (not university level)	0.030
Education - Undergraduate	0.057
Education - Postgraduate	0.041
Education - Ph. D.	0.011
Ethnicity - Asian	-0.043***
Ethnicity - Black	-0.011
Ethnicity - Mixed	-0.006
Ethnicity - Other or not specified	-0.034***
Job - Manager	-0.035**
Job - Profession	-0.003
Job - Technician or junior professional	0.004
Job - Clerical support worker	0.029**
Job - Service worker	-0.001
Job - Sales worker	-0.025***
Job - Manual labour worker	0.003
Annual income (£)	0.033***

$^{**}P < 0.01$, $^{***}P < 0.001$.

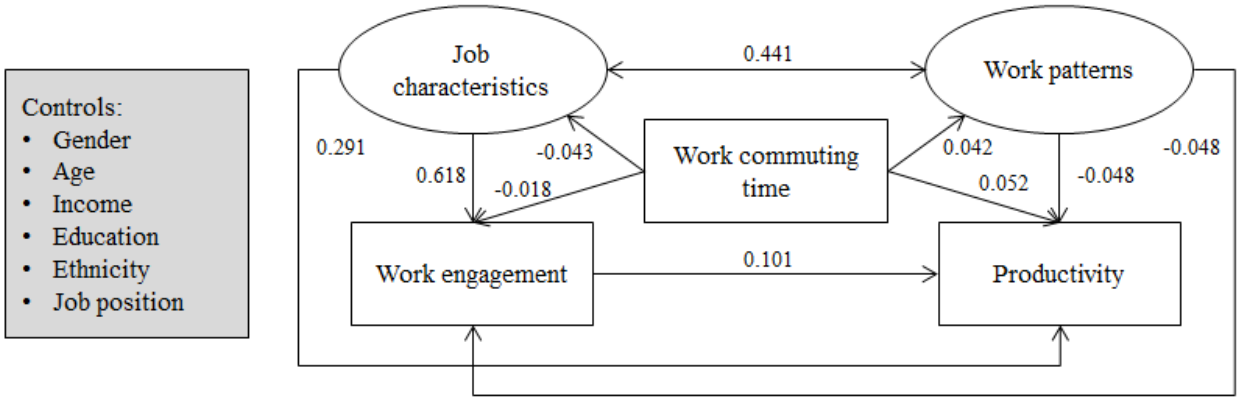
The findings from the *personal* model suggest that all of the pathway coefficients, except for the one between smoking and work engagement, are positive, meaning that better health and lifestyle generally increase work engagement and productivity. The influence of smoking on work engagement is small and may be result of individuals who take smoking breaks being more engaged while working. Most of the control variables considered in the model do not have statistically significant effect on productivity (see Table A4 in the Appendix) or other variables (not reported). In particular,

education and job position are essentially irrelevant in the analysis, except for sales workers who are less productive on average. Individuals of Asian ethnicity are generally more productive and there are additional ethnicity-specific variations in the data, particularly in alcohol consumption, sleep and general lifestyle. Finally, men, older individuals and those with higher income self-report higher productivity.

6.2 Job model - attitudes towards workplace

Complexity of the *job* model depicted in Figure 2 reflects the lower number of variables in this category. Starting with work commuting time, it has statistically significant yet small impact on all four other variables (note that the variable is also transformed, higher values thus represent shorter commuting time). The estimated effect on job characteristics and work engagement is negative but the effect on work patterns and productivity is positive. This suggests that shorter commute positively affects productivity, yet its influence on other factors is more complex. Some possible explanations are that workers who commute from further away are more committed to the job and thus show higher work engagement and job satisfaction, as well as lower stress.

Figure 2: Job model.



Notes: The diagram represents model that fits the observed data the best. Only paths with direct or indirect effect on productivity are shown with standardised coefficients. All the paths shown are statistically significant at the <0.001 level.

Influence of work patterns on both work engagement and productivity is equally low and negative (with standardised coefficients of -0.048). This suggests that allowing employees to work flexible hours and from home may slightly reduce their productivity, possibly as a result of insufficient motivation to work under limited supervision. On the other hand, the effect of job characteristics – both direct and indirect – is substantially higher and positive (with coefficients of 0.618 and 0.291 for work engagement and productivity, respectively), meaning that employees facing less stress at work and

those more satisfied with their job are on average more productive. While this confirms previous findings of e.g. AbuAlRub (2004), Judge and Kammeyer-Mueller (2008) or Judge and Kammeyer-Mueller (2012), we will see later that the direct effect decreases by more than 50% once other variables are accounted for.

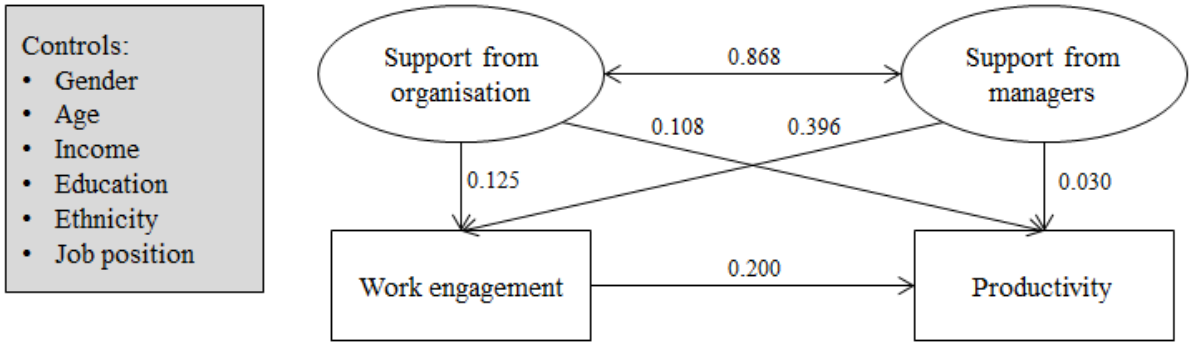
Considering work engagement, its effect on productivity is higher than in the personal model and statistically significant (with coefficient of 0.101), yet it is relatively low compared to that of job characteristics. The effect of control variables is more diverse this time, with income, gender and age being statistically significant with respect to all but commuting time, education and job position only affecting work patterns, and commuting time being affected by ethnicity. All of the effects are in the expected directions; for instance, higher educated, older and individuals at higher positions are more likely to work flexible hours and from home, while individuals earning more show higher values of job characteristics and commute longer.

6.3 Workplace model - workplace and organisational characteristics

Finally, the *workplace* model based on support from organisation and support from managers is depicted in Figure 3. As suggested by the previous literature (see e.g. Kuoppala et al., 2008 or Lewis & Malecha, 2011), both of the estimated factors are statistically significant predictors of work engagement and productivity. At the same time, both factors affect productivity mainly indirectly, through work engagement, and the direct influence is relatively low, with standardised coefficients of 0.108 and 0.030 for organisation and managers, respectively. Combined with the pathway coefficient between work engagement and productivity being twice as high as in the previous models (with coefficient of 0.200), the results again suggest that such simple models fail to properly capture the actual pathway of effects. Indeed, as we will see in the next section, most of the direct influence disappears once additional variables are considered and most of the indirect influence goes through mental health, not work engagement.

Influence of control variables is consistent to the previous models, with gender, age and income being statistically significant predictors of all four variables considered and education, ethnicity and job position not making much difference. The coefficients at gender and age with respect to organisation and manager support are negative, meaning that men and older employees feel less supported at the workplace.

Figure 3: Workplace model.



Notes: The diagram represents model that fits the observed data the best. Only paths with direct or indirect effect on productivity are shown with standardised coefficients. All the paths shown are statistically significant at the <0.001 level.

7 The overall model of workplace productivity

Based on findings from the partial models, in this section we develop a joint, comprehensive model of workplace productivity and use it to determine changes in the estimated influences. This is again done iteratively; the partial models are linked together in a SEM framework and an optimal model is found by changing model structure and observing the AIC and BIC values. The resulting model is depicted in Figure 4 and the direct and indirect influences on productivity are presented in Table 6.

The results show that once all factors are considered, mental health stands out as the most important determinant of workplace productivity with standardised coefficient of 0.363 combining both the direct (0.268) and indirect (0.950) effects. As in the partial model, most of the indirect effect is mediated by physical health (93%). Mental health is also a mediation factor for other variables. In particular, over 50% of the influence of job characteristics, the second most important productivity determinant (with combined standardised coefficient of 0.310), is mediated through mental health. At the same time, the combined effect of mental health decreased by nearly 18% compared to the partial model shown in Section 6, suggesting that the partial model captured some of the variance of the other, omitted factors correlated with mental health.

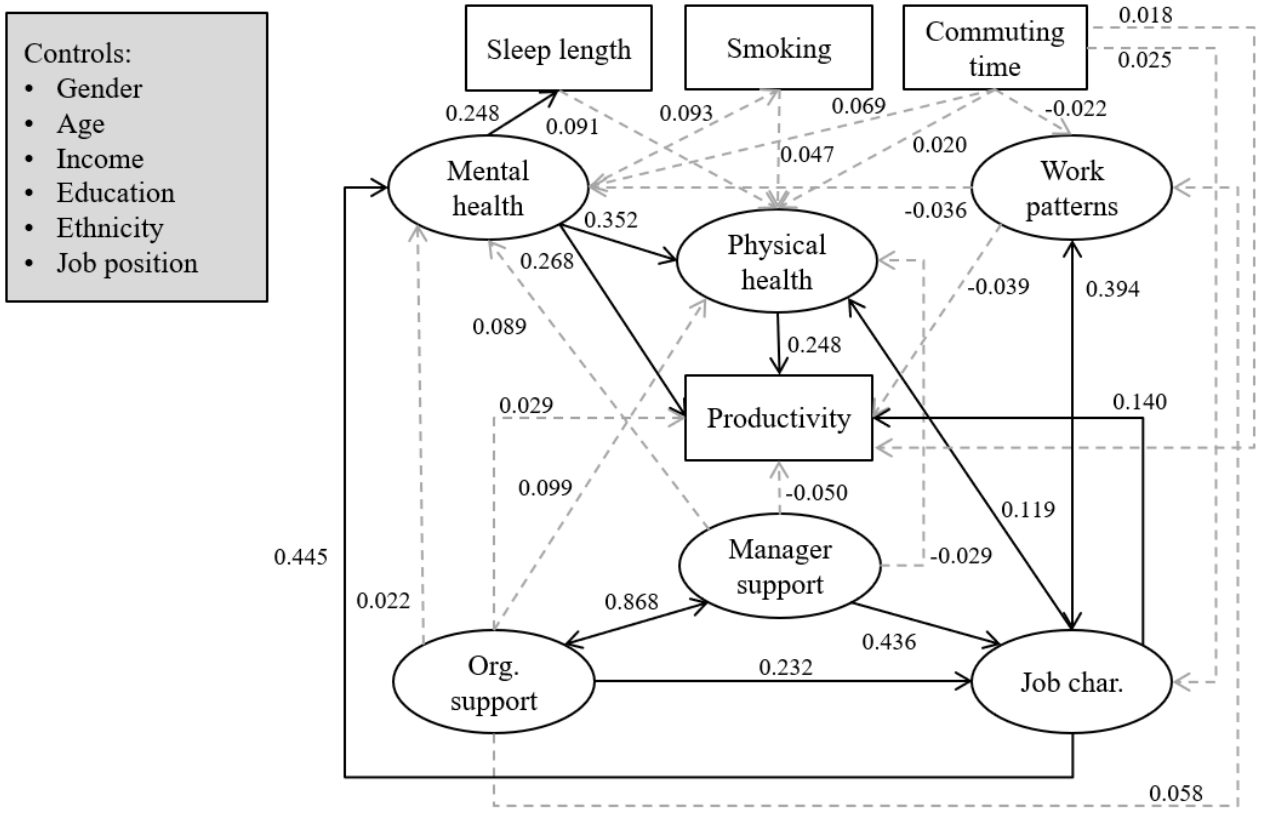
Work engagement, an important productivity determinant in the partial models, has no longer a statistically significant link to productivity in the overall model. Specifically, the effect of work engagement was strongest in the job and workplace models (with standardised coefficients of 0.101 and 0.200, respectively), where it additionally served as a mediation factor for job characteristics and for support from organisation and from managers, respectively. On the contrary, in the overall model the latter two factors are mediated through job characteristics, which are in turn mediated through mental health. The previously estimated direct effect of work engagement thus arguably incorrectly

Table 6: Direct and indirect influences on productivity

Direct influence	**Indirect influence**	**Personal model**	**Job model**	**Workplace model**	**Overall model**
Work engagement		0.051	0.101	0.200	ns
Mental health		0.296	-	-	0.268
	MH ->PH ->Prod	0.124	-	-	0.087
	Other pathways	0.021	-	-	0.007
Combined		**0.441**	**-**	**-**	**0.363**
Physical health		0.260	-	-	0.248
	All pathways	0.006	-	-	-
Combined		0.266	**-**	**-**	**0.248**
Lifestyle		ns	-	-	ns
	All pathways	0.001	-	-	ns
Combined		**0.001**	**-**	**-**	ns
Work patterns		-	-0.048	-	-0.039
	All pathways	-	-0.005	-	-0.013
Combined		**-**	**-0.053**	**-**	**-0.052**
Job characteristics		-	0.291	-	0.140
	JC ->MH ->Prod	-	-	-	0.156
	Other pathways	-	0.0390	-	0.014
Combined		**-**	**0.330**	**-**	**0.310**
Manager support		-	-	0.030[a]	-0.050
	MS ->JC ->Prod	-	-	-	0.135
	Other pathways	-	-	0.194	0.025
Combined		**-**	**-**	**0.224**	**0.110**
Org. Support		-	-	0.108	0.029[a]
	OS ->JC ->Prod	-	-	-	0.190
	Other pathways	-	-	0.025	0.008
Combined		**-**	**-**	**0.133**	**0.226**
Smoking		ns	-	-	ns
	All pathways	0.009	-	-	0.012
Combined		**0.009**	**-**	**-**	**0.012**
Alcohol		ns	-	-	ns
	All pathways	0.002	-	-	ns
Combined		**0.002**	**-**	**-**	ns
Sleep length		ns	-	-	ns
	All pathways	0.027	-	-	0.023
Combined		**0.027**	**-**	**-**	**0.023**
Commuting time		-	0.052	-	0.018
	All pathways	-	0.014	-	0.039
Combined		**-**	**0.066**	**-**	**0.057**

Notes: [a] Significant at the 0.01 level. All other reported results statistically significant at the <0.001 level. ns = not significant. Only selected indirect pathways shown. MH = mental health, PH = physical health, Prod = productivity, JC = Job characteristics, MS = manager support, OS = Organisation support. For all variables, higher values represent preferable outcomes.

Figure 4: Overall model.



Notes: The diagram represents model that fits the observed data the best. Uncorrelated error variables are omitted for clarity of presentation. Solid black lines highlight pathway coefficients greater than 0.1. All the paths shown are statistically significant at the <0.001 level.

captures the influence of mental and physical health, which are omitted from the models.

The second strongest direct influence in the model comes from physical health (0.248), which is only modelled to have a direct influence on productivity. Its direct influence decreased by less than 7% compared to the partial model. The direct effect of mental health decreased by 10%. For all other variables, the direct effects are substantially lower than in the partial models (e.g. by 52% for job characteristics or 73% for support from organisation). These findings again highlight the risk of narrow models providing misleading results due to the omitted-variable bias.

Out of the seven latent factor variables included in the analysis, workplace productivity is most dependent on mental health, physical health, job characteristics and support from organisation, showing that the determinants indeed cover all three broad models. It is therefore essential for organisations striving to create an optimal workplace environment to promote the overall organisational, work and management culture as well as to support physical and mental wellbeing of their employees. On the other hand, work patterns have a small estimated influence, suggesting that the way employees work is not an essential productivity determinant.

Considering the four individual variables – alcohol consumption, smoking, sleep length and commuting time – only commuting time is estimated to have statistically significant direct effect on productivity, while even the indirect effect of alcohol consumption is not significant any more. Looking at Table A4 in the Appendix, the influence of control variables remains remarkably consistent, with gender, age, income and selected ethnicity and job position indicators having statistically significant influence on productivity. In particular, men, older employees and those with higher income tend to report higher productivity.

8 Discussion

The analysis presented in this study has two potential drawbacks. First, using only cross-sectional data it is limited in dealing with the complex endogeneity bias. In order to overcome the issue, each of the models is estimated numerous times, each time with one of the pathways in an opposite direction to see which model structure would fit the data better. Second, as with all survey-based datasets, one's perception of the job, workplace, their current physical and mental health, or even mood at the time of taking the survey may affect, to some extent, the submitted responses. Hence, it is possible that individuals not particularly satisfied with their job will be more critical towards their managers and the workplace as a whole or that those with poor mental wellbeing will be more negative about other personal characteristics as well. We control for both systematic and non-systematic measurement errors in the analysis using latent variables with an explicit correlation structure among the error terms. Finally, we assessed representativeness of our dataset by comparing it to a representative sample of the UK employee population using the Health Survey for England. (2016)[3] The analysis suggests that the samples are comparable in their characteristics, although the presented dataset contains disproportionately many responses from individuals of white ethnicity (see Section 4 for more information).

Notwithstanding the imperfections, the study presents an important insight into understanding employee productivity. Implications of the findings presented above are threefold.

First, certain factors, namely physical health, mental health, job characteristics, and support from organisation are considerably more important determinants of employee productivity than the other analysed variables. It is clear from the recent surge in workplace interventions aimed at improving employees' wellbeing and interest in public debate that this fact is becoming increasingly accepted by the employers and policymakers alike. Combined with results such as that organisational climate (Kaliprasad, 2006) or appreciation and positive relations with colleagues (Walker, 2001) increase

[3] UK Government Statistical Service (2016).

employee retention, there is a strong case for employers to create a positive working environment with happier and more productive employees.

Second, most of the other variables included in the analysis, such as support from managers or sleep length, also show statistically significant although not as strong influence on productivity. This supports the message from the previous point; even though employees' personal characteristics play main role in determining their productivity, the workplace and organisational factors not only affect productivity indirectly through employees' physical and mental health, they also have distinct direct effects.

Third, while all of statistically significant influences have been suggested in the prior literature, the framework of determinants behind employee productivity is more complex than often presented. Indeed, we can see from Table 6 that not only majority of the detected effects decreases as additional variables are included in the estimation, some of the previously highlighted links disappear altogether. Conditional on data and conceptual limitations, future studies should therefore endeavour to be as inclusive as possible in order to overcome the omitted-variable bias.

9 Conclusions

This paper seeks to understand determinants of employee productivity at the workplace and highlight the importance of considering wide range of personal and institutional factors in such analysis in order to prevent an omitted-variable bias. Using a cross-sectional dataset of 29,928 employees in the UK who participated in the Britain's Healthiest Workplace survey in 2017, we develop three individual SEMs used to estimate the individual, job, and workplace models, reflecting influences of a particular set of thematically similar variables in isolation. The models confirm findings from the prior literature, showing that factors such as mental health, work engagement or support from managers are important determinants of workplace productivity. However, once the three models are combined the total influence of some variables substantially decreases or, as in the case of work engagement or lifestyle, completely disappears. The results show that mental health, physical health, job characteristics and support from organisation are the most important determinants of productivity and also act as mediators for other factors.

The results confirm previous findings regarding pathways of effects, but also highlight the importance of considering the broader picture in order to avoid the omitted-variable bias. Indeed, some of the initially strong influences on productivity, notably the impact of lifestyle factors or work engagement, become statistically insignificant once additional variables are included in the model.

In addition, other variables, such as workplace and organisational environment, remain statistically significant determinants but lose most of their explanatory power once other factors are considered.

Compliance with Ethical Standards:

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References

AbuAlRub, R. F. (2004). Job stress, job performance, and social support among hospital nurses. *Journal of nursing scholarship*, *36*(1), 73–78.

Akhtar, R., Boustani, L., Tsivrikos, D., & Chamorro-Premuzic, T. (2015). The engageable personality: Personality and trait ei as predictors of work engagement. *Personality and Individual Differences*, *73*, 44–49.

Alonso, J., Petukhova, M., Vilagut, G., Chatterji, S., Heeringa, S., Üstün, T. B., ... others (2011). Days out of role due to common physical and mental conditions: results from the who world mental health surveys. *Molecular psychiatry*, *16*(12), 1234–1246.

Anitha, J. (2014). Determinants of employee engagement and their impact on employee performance. *International journal of productivity and performance management*.

Bakker, A. B., & Demerouti, E. (2008). Towards a model of work engagement. *Career development international*, *13*(3), 209–223.

Bakker, A. B., Hakanen, J. J., Demerouti, E., & Xanthopoulou, D. (2007). Job resources boost work engagement, particularly when job demands are high. *Journal of educational psychology*, *99*(2), 274.

Boles, M., Pelletier, B., & Lynch, W. (2004). The relationship between health risks and work productivity. *Journal of Occupational and Environmental Medicine*, *46*(7), 737–745.

Bouchery, E. E., Harwood, H. J., Sacks, J. J., Simon, C. J., & Brewer, R. D. (2011). Economic costs of excessive alcohol consumption in the us, 2006. *American journal of preventive medicine*, *41*(5), 516–524.

Braakman-Jansen, L. M., Taal, E., Kuper, I. H., & van de Laar, M. A. (2011). Productivity loss due to absenteeism and presenteeism by different instruments in patients with ra and subjects without ra. *Rheumatology*, *51*(2), 354–361.

Brown, H. E., Gilson, N. D., Burton, N. W., & Brown, W. J. (2011). Does physical activity impact on presenteeism and other indicators of workplace well-being? *Sports Medicine*, *41*(3), 249–262.

Collins, J. J., Baase, C. M., Sharda, C. E., Ozminkowski, R. J., Nicholson, S., Billotti, G. M., ... Berger, M. L. (2005). The assessment of chronic health conditions on work performance, absence, and total economic impact for employers. *Journal of Occupational and Environmental Medicine*, *47*(6), 547–557.

Darr, W., & Johns, G. (2008). *Work strain, health, and absenteeism: a meta-analysis*. Educational Publishing Foundation.

Demerouti, E., & Cropanzano, R. (2010). From thought to action: Employee work engagement and job performance. *Work engagement: A handbook of essential theory and research*, *65*, 147–163.

Ford, M. T., Cerasoli, C. P., Higgins, J. A., & Decesare, A. L. (2011). Relationships between psychological, physical, and behavioural health and work performance: A review and meta-analysis. *Work & Stress*, *25*(3), 185–204.

Frone, M. R. (2006). Prevalence and distribution of alcohol use and impairment in the workplace: a us national survey. *Journal of studies on alcohol*, *67*(1), 147–156.

Gates, D. M., Succop, P., Brehm, B. J., Gillespie, G. L., & Sommers, B. D. (2008). Obesity and presenteeism: the impact of body mass index on workplace productivity. *Journal of Occupational and Environmental Medicine*, *50*(1), 39–45.

Goetzel, R. Z., Long, S. R., Ozminkowski, R. J., Hawkins, K., Wang, S., & Lynch, W. (2004). Health, absence, disability, and presenteeism cost estimates of certain physical and mental health conditions affecting us employers. *Journal of Occupational and Environmental Medicine*, *46*(4), 398–412.

Hafner, M., Stepanek, M., Taylor, J., Troxel, W. M., & Van Stolk, C. (2016). Why sleep matters–the economic costs of insufficient sleep.

Hakanen, J. J., Bakker, A. B., & Demerouti, E. (2005). How dentists cope with their job demands and stay engaged: The moderating role of job resources. *European journal of oral sciences*, *113*(6), 479–487.

Hansen, C. D., & Andersen, J. H. (2008). Going ill to work–what personal circumstances, attitudes and work-related factors are associated with sickness presenteeism? *Social science & medicine*, *67*(6), 956–964.

Health and Safety Executive. (n.d.). *HSE management standards indicator tool.* Retrieved 2018-02-28, from http://www.hse.gov.uk/stress/assets/docs/indicatortool.pdf

Hedge, A., & Ray, E. J. (2004). Effects of an electronic height-adjustable worksurface on computer worker musculoskeletal discomfort and productivity. In *Proceedings of the human factors and ergonomics society annual meeting* (Vol. 48, pp. 1091–1095).

Hex, N., Bartlett, C., Wright, D., Taylor, M., & Varley, D. (2012). Estimating the current and future costs of type 1 and type 2 diabetes in the uk, including direct health costs and indirect societal and productivity costs. *Diabetic Medicine*, *29*(7), 855–862.

Hilton, M. F., Scuffham, P. A., Vecchio, N., & Whiteford, H. A. (2010). Using the interaction of mental health symptoms and treatment status to estimate lost employee productivity. *Australian & New Zealand Journal of Psychiatry*, *44*(2), 151–161.

Hoyle, R. (1995). *The structural equation modelling approach: Basic concepts and fundamentals issues, hoyle, rh (eds), structural equation modelling: Concepts, issues, and applications.* SAGE.

Hutting, N., Engels, J. A., Heerkens, Y. F., Staal, J. B., & Nijhuis-Van der Sanden, M. W. (2014). Development and measurement properties of the dutch version of the stanford presenteeism scale (sps-6). *Journal of occupational rehabilitation*, *24*(2), 268–277.

Jahanshahi, K., Jin, Y., & Williams, I. (2015). Direct and indirect influences on employed adults' travel in the uk: New insights from the national travel survey data 2002–2010. *Transportation Research Part A: Policy and Practice*, *80*, 288–306.

Jex, S. M., & Britt, T. W. (2014). *Organizational psychology: A scientist-practitioner approach.* John Wiley & Sons.

Johns, G. (2010). Presenteeism in the workplace: A review and research agenda. *Journal of Organizational Behavior*, *31*(4), 519–542.

Johns, G. (2011). Attendance dynamics at work: the antecedents and correlates of presenteeism, absenteeism, and productivity loss. *Journal of Occupational Health Psychology*, *16*(4), 483.

Judge, T. A., & Kammeyer-Mueller, J. D. (2008). Affect, satisfaction, and performance. *Research companion to emotion in organizations*, 136–151.

Judge, T. A., & Kammeyer-Mueller, J. D. (2012). Job attitudes. *Annual review of psychology*, *63*, 341–367.

Kaliprasad, M. (2006). The human factor. i: Attracting, retaining, and motivating capable people. *Cost Engineering*, *48*(6), 20–26.

Kessler, R. C., Andrews, G., Colpe, L. J., Hiripi, E., Mroczek, D. K., Normand, S.-L., ... Zaslavsky, A. M. (2002). Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychological medicine*, *32*(6), 959–976.

Kuoppala, J., Lamminpää, A., Liira, J., & Vainio, H. (2008). Leadership, job well-being, and health effects—a systematic review and a meta-analysis. *Journal of occupational and environmental medicine*, *50*(8), 904–915.

Lal, A., Moodie, M., Ashton, T., Siahpush, M., & Swinburn, B. (2012). Health care and lost productivity costs of overweight and obesity in new zealand. *Australian and New Zealand journal of public health*, *36*(6), 550–556.

Lewis, P. S., & Malecha, A. (2011). The impact of workplace incivility on the work environment, manager skill, and productivity. *Journal of Nursing Administration*, *41*(1), 41–47.

Litwin, H., & Shiovitz-Ezra, S. (2006). The association between activity and wellbeing in later life: what really matters? *Ageing & Society*, *26*(2), 225–242.

Martimo, K.-P., Shiri, R., Miranda, H., Ketola, R., Varonen, H., & Viikari-Juntura, E. (2009). Self-reported productivity loss among workers with upper extremity disorders. *Scandinavian journal of work, environment & health*, 301–308.

Merrill, R. M., Aldana, S. G., Pope, J. E., Anderson, D. R., Coberley, C. R., Whitmer, & the HERO Research Study Subcommittee, R. W. (2012). Presenteeism according to healthy behaviors, physical health, and work environment. *Population Health Management*, *15*(5), 293–301.

Miraglia, M., & Johns, G. (2016). Going to work ill: A meta-analysis of the correlates of presenteeism and a dual-path model. *Journal of Occupational Health Psychology*, *21*(3), 261.

Motowildo, S. J., Borman, W. C., & Schmit, M. J. (1997). A theory of individual differences in task and contextual performance. *Human performance*, *10*(2), 71–83.

Mueller, R., Hancock, G., et al. (2010). Structural equation modeling. *The reviewer's guide to quantitative methods in the social sciences*, 371–383.

Parsonage, M. (2007). Mental health at work: Developing the business case. *Policy Paper*, *8*.

Patterson, M. G., West, M. A., Shackleton, V. J., Dawson, J. F., Lawthom, R., Maitlis, S., ... Wallace, A. M. (2005). Validating the organizational climate measure: links to managerial practices, productivity and innovation. *Journal of organizational behavior*, *26*(4), 379–408.

Pereira, M. J., Coombes, B. K., Comans, T. A., & Johnston, V. (2015). The impact of onsite workplace health-enhancing physical activity interventions on worker productivity: a systematic review. *Occup Environ Med*, oemed–2014.

Reilly, M. C., Zbrozek, A. S., & Dukes, E. M. (1993). The validity and reproducibility of a work productivity and activity impairment instrument. *Pharmacoeconomics*, *4*(5), 353–365.

Rongen, A., Robroek, S. J., Schaufeli, W., & Burdorf, A. (2014). The contribution of work engagement to self-perceived health, work ability, and sickness absence beyond health behaviors and work-related factors. *Journal of occupational and environmental medicine*, *56*(8), 892–897.

Rosekind, M. R., Gregory, K. B., Mallis, M. M., Brandt, S. L., Seal, B., & Lerner, D. (2010). The cost of poor sleep: workplace productivity loss and associated costs. *Journal of Occupational and Environmental Medicine*, *52*(1), 91–98.

Salanova, M., Agut, S., & Peiró, J. M. (2005). Linking organizational resources and work engagement to employee performance and customer loyalty: the mediation of service climate. *Journal of applied Psychology*, *90*(6), 1217.

Schaufeli, W. B., Bakker, A. B., & Salanova, M. (2006). The measurement of work engagement with a short questionnaire: A cross-national study. *Educational and psychological measurement*, *66*(4), 701–716.

Shanock, L. R., & Eisenberger, R. (2006). When supervisors feel supported: Relationships with subordinates' perceived supervisor support, perceived organizational support, and performance. *Journal of Applied psychology*, *91*(3), 689.

StataCorp. (2017). Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC.

Staufenbiel, T., & König, C. J. (2010). A model for the effects of job insecurity on performance, turnover intention, and absenteeism. *Journal of Occupational and Organizational Psychology*, *83*(1), 101–117.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics*. Allyn & Bacon/Pearson Education.

Tarafdar, M., Tu, Q., Ragu-Nathan, B. S., & Ragu-Nathan, T. (2007). The impact of technostress on role stress and productivity. *Journal of Management Information Systems*, *24*(1), 301–328.

Tunceli, K., Bradley, C. J., Nerenz, D., Williams, L. K., Pladevall, M., & Lafata, J. E. (2005). The impact of diabetes on employment and work productivity. *Diabetes care*, *28*(11), 2662–2667.

UK Government Statistical Service. (2016). *Health survey for england.* Retrieved from https://digital.nhs.uk/data-and-information/publications/statistical/health-survey-for-england/health-survey-for-england-2016

Walker, J. (2001). Zero defections? *Human Resource Planning*, *24*(1), 6–8.

Wolf, A. M., Siadaty, M. S., Crowther, J. Q., Nadler, J. L., Wagner, D. L., Cavalieri, S. L., ... Bovbjerg, V. E. (2009). Impact of lifestyle intervention on lost productivity and disability: improving control with activity and nutrition (ican). *Journal of occupational and environmental medicine/American College of Occupational and Environmental Medicine*, *51*(2), 139.

World Health Organisation. (1946). *Constitution of the world health organisation.* Retrieved 2018-02-28, from http://apps.who.int/gb/bd/PDF/bd47/EN/constitution-en.pdf

Xanthopoulou, D., Bakker, A. B., Demerouti, E., & Schaufeli, W. B. (2009). Work engagement and financial returns: A diary study on the role of job and personal resources. *Journal of occupational and organizational psychology*, *82*(1), 183–200.

Zelenski, J. M., Murphy, S. A., & Jenkins, D. A. (2008). The happy-productive worker thesis revisited. *Journal of Happiness Studies*, *9*(4), 521–537.

Appendix

Table A1: Descriptive statistics - variables

Variable	Scale	Mean	Std. dev.	Median	Min	Max
Smoking	Smoker/Nonsmoker	0.63	0.48	1	0	1
Alcohol consumption	Units per week	128.74	13.37	133	0	140
Exercise	Minutes per week	296.32	294.72	230	0	4,200
Fruits & vegetables	Portions per day	4.94	2.42	5	0	40
Sleep length	Hours per day	6.99	0.94	7	1	20
Dietary fats and oils	Portions per day	3.35	1.03	3	0	5
Trans-unsaturated fatty acids	Portions per day	5.67	1.20	6	0	7
Low-fat dairy products	Portions per day	3.97	1.58	4	1	6
Mental health self-assessment	Poor-excellent	2.96	0.89	3	0	4
Psychological distress	0-24	19.32	4.09	20	0	24
Life satisfaction	0-10	6.92	1.81	7	0	10
Financial concerns	A lot; A little; None	1.44	0.63	2	0	2
Physical health self-assessment	0-10	2.93	0.79	3	0	4
BMI	kg/m^2	59.26	5.12	60.1	0	79.9
# musculoskeletal health conditions	0-9	6.91	1.84	7	0	9
# chronic conditions	0-16	15.62	0.70	16	10	16
MSK unable to work	Yes/No	0.85	0.35	1	0	1
Fatigue	Always-Never	2.28	0.99	2	0	4
Job satisfaction	0-10	4.22	1.48	5	0	6
Work stress	0-7	6.05	1.20	6	0	7
Flexible hours	No/Yes	0.56	0.50	1	0	1
Home work	No/Yes	0.52	0.50	1	0	1
Isolation	Always-Never	3.17	0.95	3	0	4
Safety	Never-Always	4.60	0.65	5	1	5
Commuting time	Minutes/day (one way)	138.51	29.96	145	0	180
Support - physical activity	Disagree-Agree	3.19	1.01	3	1	5
Support - diet	Disagree-Agree	3.08	0.99	3	1	5
Support - smoking	Disagree-Agree	3.09	0.93	3	1	5
Support - stress	Disagree-Agree	3.02	0.99	3	1	5
Support - unwell	Disagree-Agree	3.58	0.90	4	1	5
Manager encouragement	Disagree-Agree	3.83	0.95	4	1	5
Managar wellbeing	Disagree-Agree	3.86	0.92	4	1	5
Wellbeing importance for the org.	Disagree-Agree	3.43	1.07	4	1	5
Discussion with line manager	Disagree-Agree	3.09	1.26	3	1	5
Discussion with HR representative	Disagree-Agree	2.87	1.21	3	1	5
Discussion with colleague	Disagree-Agree	3.05	1.17	3	1	5
Work engagement	0-6 (continuous)	3.62	0.92	3.7	0	6
Productivity	0%-100%	0.88	0.20	1	0	1

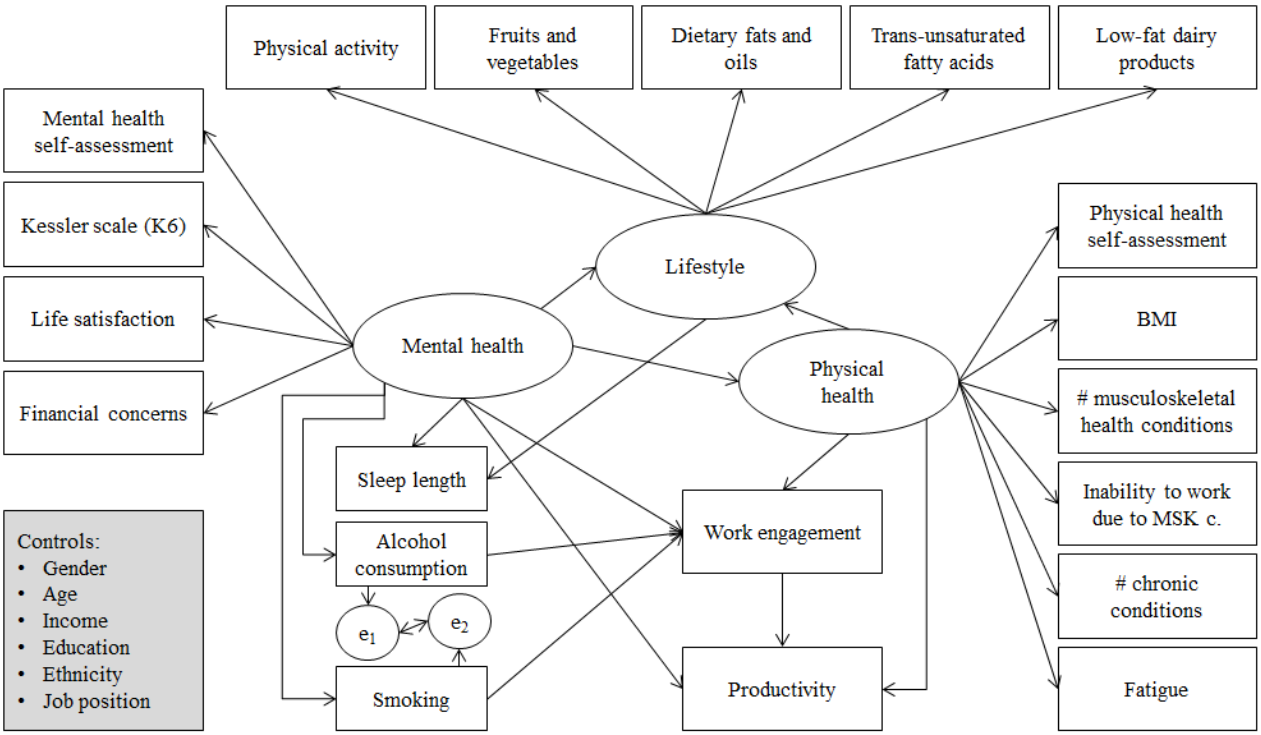
n = 29,928. For all variables, higher values represent preferable outcomes.

Table A2: Descriptive statistics - controls

Variable	Mean	Std. dev.	Min	Max
Gender	0.50	0.50	0	1
Age	39.15	11.26	18	82
Education - none or primary (baseline)	0.00	0.07	0	1
Education - First cycle of secondary	0.08	0.28	0	1
Education - Second cycle of secondary	0.13	0.33	0	1
Education - Post-secondary (not university level)	0.19	0.39	0	1
Education - Undergraduate	0.36	0.48	0	1
Education - Postgraduate	0.21	0.41	0	1
Education - Ph. D.	0.02	0.14	0	1
Ethnicity - white (baseline)	0.92	0.28	0	1
Ethnicity - Asian	0.04	0.20	0	1
Ethnicity - Black	0.01	0.12	0	1
Ethnicity - Mixed	0.02	0.12	0	1
Ethnicity - Other or not specified	0.01	0.12	0	1
Job - Manager	0.25	0.43	0	1
Job - Profession	0.35	0.48	0	1
Job - Technician or junior professional	0.14	0.35	0	1
Job - Clerical support worker	0.14	0.34	0	1
Job - Service worker	0.02	0.15	0	1
Job - Sales worker	0.03	0.16	0	1
Job - Manual labour worker	0.01	0.12	0	1
Job - Other or not specified (baseline)	0.06	0.24	0	1
Annual income (£)	43,925	29,194	5,000	150,000

n = 29,928

Figure A1: Personal model.



Notes: The diagram represents model that fits the observed data the best.

Table A3: Composite variables used in the questionnaire

Scale	Question
Kessler Psych. Distress Scale (K6)[a] (0 - None of the time; 4 - All of the time)	During the last 30 days, about how often did you feel: 1. . . . nervous? 2. . . . hopeless? 3. . . . restless or fidgety? 4. . . . that everything was an effort? 5. . . . so depressed that nothing could cheer you up? 6. . . . worthless?
HSE Management Standards[b] (0 - Never; 4 - Always)	1. I have a choice in deciding what I do at work. 2. I have unrealistic time pressures. 3. I am clear what my duties and responsibilities are. 4. I receive the respect at work I deserve from my colleagues. 5. Staff are always consulted about change at work. 6. Relationships at work are strained. 7. I am subject to bullying at work.
Utrecht Work Engagement Scale[c] (0 - Never; 6 - Always)	1. At my work, I feel bursting with energy 2. At my job, I feel strong and vigorous 3. I am enthusiastic about my job 4. My job inspires me 5. When I get up in the morning, I feel like going to work 6. I feel happy when I am working intensely 7. I am proud of the work that I do 8. I am immersed in my work 9. I get carried away when I am working
Work Productivity and Activity Impairment[d] (General Health Questionnaire)	1. During the past seven days, how many hours did you actually work? 2. During the past seven days, how many hours did you miss from work because of health problems? 3. During the past seven days, how much did your health problems (physical and/or mental) affect your productivity while you were working?

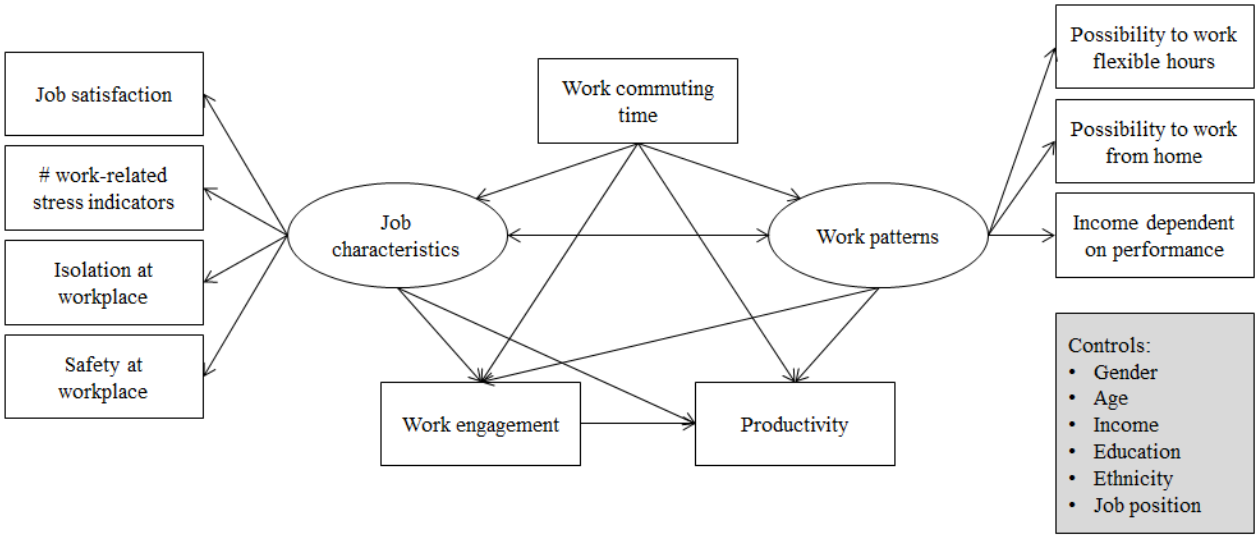
[a] Kessler et al. (2002). Scores for all questions were summed up, forming a 0-24 scale.

[b] Selected questions from Health and Safety Executive (n.d.). Employees are considered at stress in given indicator if they select 3 or 4 in negatively-oriented questions (no. 2, 6, 7) and 0 or 1 in positively-oriented questions (no. 1, 3, 4, 5).

[c] Schaufeli et al. (2006). Scores for all questions were averaged.

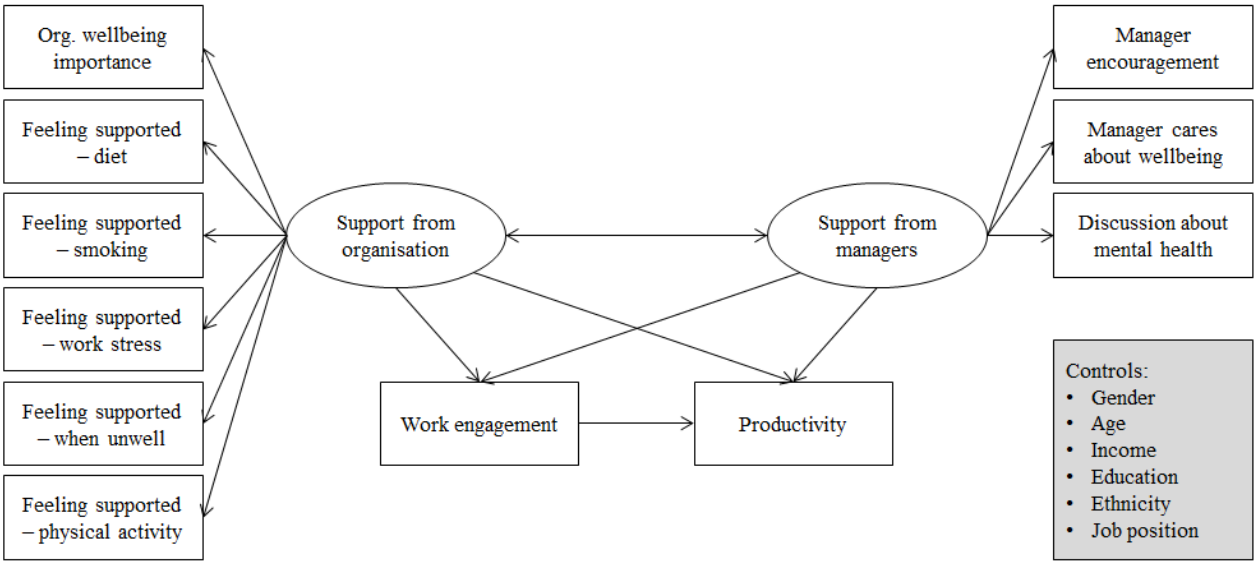
[d] Reilly, Zbrozek, and Dukes (1993). Productivity loss is calculated as $l = a/(a+w) + (1 - a/(a+w)) * p/10$, where w is the number of hours worked (Q1), a is a measure of absenteeism (Q2) and p is measure of presenteeism (Q3). Q3 is on scale 0–10.

Figure A2: Job model.



Notes: The diagram represents model that fits the observed data the best.

Figure A3: Workplace model.



Notes: The diagram represents model that fits the observed data the best.

Table A4: Direct and indirect influences of control variables on productivity

Direct influence	Indirect influence	Personal model	Job model	Workplace model	Overall model
Gender - Male		0.049*	0.077*	0.075*	0.051*
	All pathways	-	-0.022*	-0.019*	-
Combined		0.056*	0.055*	0.056*	0.056*
Age		0.066*	0.073*	0.071*	0.069*
	All pathways	-	-	-	-
Combined		0.071*	0.068*	0.071*	0.071*
Education - First cycle of secondary		0.065	-	-	0.063
	All pathways	-0.033	-	-	-0.031
Combined		-	-	-	-
Education - Second cycle of secondary		-	-	-	-
	All pathways	-0.041	-	-	-0.041
Combined		-	-	-	-
Education - Post-secondary (not university level)		-	-	-	-
	All pathways	-0.053	-	-	-0.054
Combined		-	-	-	-
Education - Undergraduate		-	-	-	-
Education - Postgraduate		-	-	-	-
Education - Ph. D.		-	-	-	-
Ethnicity - Asian		-0.024*	-0.035*	-0.040*	-0.023*
	All pathways	-0.009		0.007*	-0.010
Combined		-0.033	-0.033	-0.033	-0.033
Ethnicity - Black		-	-	-	-
Ethnicity - Mixed		-	-	-	-
	All pathways	-0.010	-	-	-0.010*
Combined		-	-	-	-
Ethnicity - Other or not specified		-0.025*	-0.026*	-0.032*	-0.022*
	All pathways	-0.010	-0.009*	-	-0.013*
Combined		-0.035*	-0.035*	-0.035*	-0.035*
Job - Manager		-	-	-0.031	-
	All pathways	-	0.012	0.020*	-
Combined		-	-	-	-
Job - Professional		-	-	-	-
Job - Technician or junior professional		-	-	-	-
	All pathways	-	-0.011	-0.011*	-
Combined		-	-	-	-
Job - Clerical support worker		-	-	-	-
	All pathways	-	-	-0.011	-
Combined		-	-	-	-
Job - Service worker		-	-	-	-
Job - Sales worker		-0.019	-0.020	-0.021	-0.018
	All pathways	-	-0.007	-0.006	-0.010
Combined		-0.028*	-0.027*	-0.028*	-0.028*
Job - Manual labour worker		-	-	-	-
	All pathways	-	-0.012*	-0.013*	-
Combined		-	-	-	-
Annual income (£)		-	0.038*	0.028*	-
	All pathways	0.073*	0.029*	0.031*	0.066*
Combined		0.058*	0.067*	0.058*	0.058*

Notes: * statistically significant at the <0.001 level. All other reported results statistically significant at the 0.01 level. ns = not significant. For all variables, higher values represent preferable outcomes. No or primary education, white ethnicity and other or not specified job category are used as baseline.

Table A5: Results of the preliminary Exploratory Factor Analysis

Model/ Subcategory	**Factor**	**Eigenvalue**	**Variable**	**Factor 1**	**Factor 2**	**Uniq.**
Personal model						
Mental health	Factor 1	1.799	Mental health self-assessment	0.742	-0.072	0.445
	Factor 2	0.024	Kessler scale	0.764	-0.043	0.414
	Factor 3	-0.139	Life satisfaction	0.687	0.050	0.526
	Factor 4	-0.183	Financial concerns	0.440	0.119	0.792
Physical health	Factor 1	1.233	Physical health self-assessment	0.576	-0.155	0.644
	Factor 2	0.182	BMI	0.373	-0.283	0.780
	Factor 3	-0.031	# MSK conditions	0.489	0.175	0.730
	Factor 4	-0.095	# chronic conditions	0.425	-0.036	0.818
	Factor 5	-0.156	MSK unable to work	0.401	0.137	0.821
	Factor 6	-0.228	Fatigue	0.427	0.165	0.791
Lifestyle	Factor 1	0.675	Smoking	0.089	0.316	0.892
	Factor 2	0.230	Alcohol use	0.062	0.323	0.892
	Factor 3	0.082	Exercise	0.298	-0.056	0.908
	Factor 4	-0.011	Fruit intake	0.417	-0.038	0.825
	Factor 5	-0.078	Sleep length	0.128	0.091	0.975
	Factor 6	-0.116	Fat intake	0.377	0.049	0.856
	Factor 7	-0.147	Trans-fat intake	0.403	-0.100	0.828
	Factor 8	-0.197	Dairy intake	0.284	-0.022	0.919
Job model	Factor 1	1.495	Job satisfaction	0.651	-0.109	0.564
	Factor 2	0.468	Work-related stress	0.671	-0.079	0.543
	Factor 3	0.032	Flexible hours	0.282	0.393	0.766
	Factor 4	-0.011	Work from home	0.275	0.465	0.708
	Factor 5	-0.146	Isolation	0.546	-0.218	0.655
	Factor 6	-0.192	Safety	0.408	0.009	0.833
	Factor 7	-0.248	Commuting time	-0.001	-0.179	0.968
Workplace model	Factor 1	3.580	Support: Phys. Activity	0.690	-0.335	0.412
	Factor 2	0.914	Support: Diet	0.714	-0.374	0.351
	Factor 3	0.134	Support: Smoking	0.577	-0.289	0.583
	Factor 4	0.004	Support: Stress	0.741	-0.123	0.435
	Factor 5	-0.046	Support: Unwell	0.627	0.067	0.602
	Factor 6	-0.080	Manager encouragement	0.614	0.511	0.362
	Factor 7	-0.124	Manager wellbeing	0.663	0.515	0.296
	Factor 8	-0.155	Wellbeing importance	0.540	-0.040	0.707
	Factor 9	-0.176	Openness to discussion	0.459	0.175	0.759

Table A6: Spearman's rank correlation coefficient matrix of the measured variables

	Variables	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.
1.	Smoking	1																																				
2.	Alcohol concerns	.15	1																																			
3.	Exercise	.05	-.07	1																																		
4.	Fruits & vegetables	.03		**.24**	1																																	
5.	Sleep length	.06		.08	.07	1																																
6.	Fats intake	.05	.05	.12	.14	.03	1																															
7.	Trans-fats	-.03	-.06	.16	**.22**	.07	**.21**	1																														
8.	Dairy products			.05	.15		.16	.14	1																													
9.	Mental health SA	.08		.16	.12	.16	.04	.12	.04	1																												
10.	Psych. distress	.07		.13	.13	.16	.06	.15	.08	**.60**	1																											
11.	Life satisfaction	.06		.13	.13	.20	.03	.10	.06	**.51**	**.50**	1																										
12.	Financial concerns	.10		.07	.08	.13	.05	.08	.05	**.27**	**.31**	**.35**	1																									
13.	Physical health SA	.11	-.02	**.38**	**.20**	.17	.10	.16	.04	**.46**	**.31**	**.32**	**.20**	1																								
14.	BMI	.10	.02	.14	.05	.13	.05	.04	-.10	.10	.03	.08	.10	**.34**	1																							
15.	# MSK	.06		.10	.04	.14	.05	.05		**.23**	**.25**	.19	.14	**.24**	.11	1																						
16.	# chronic conditions	.06	-.04	.11		.08	.03	.03	-.04	.17	.12	.12	.08	**.25**	.16	.18	1																					
17.	MSK able to work	.06		.08	.03	.09	.04	.03		.15	.16	.13	.12	.20	.10	**.26**	.18	1																				
18.	Fatigue	.04		.13	.07	.17	.05	.09	.03	**.38**	**.46**	**.35**	**.20**	**.26**	.07	**.28**	.14	.18	1																			
19.	Job satisfaction	.02		.05	.07	.13		.05	.04	**.32**	**.33**	**.47**	**.21**	.19	.04	.15	.06	.12	**.35**	1																		
20.	Work stress	.04		.06	.06	.12		.05		**.24**	**.27**	**.29**	.17	.16	.08	.15	.09	.13	**.34**	**.49**	1																	
21.	Flexible hours	.03	-.02	.03	.02	.04				.06	.07	.11	.08	.06		.03	.03	.05	.10	.15	.17	1																
22.	Home work	.04	-.09	.06	.04		.04	.07	.02	.07	.10	.10	.10	.08	.04		.05	.06	.08	.12	.17	**.36**	1															
23.	Isolation	.02		.04	.04	.12	.02	.05	.04	**.33**	**.37**	**.32**	.16	.16	.06	.17	.08	.11	**.36**	**.39**	**.35**	.06		1														
24.	Safety	.04	-.04	.04	.03	.06	.04	.07	.04	.18	.20	.18	.12	.14	.06	.09	.05	.10	.19	**.23**	**.21**	.10	.14	**.26**	1												
25.	Commuting time		.03			.12				.03		.06	.04	.04		.02			.04				-.14	.04		1											
26.	Support - PA			.12	.09	.09	.03	.05	.03	.16	.16	**.21**	.10	.16	.09	.11	.07	.08	**.22**	**.31**	**.31**	.14	.13	**.21**	.17		1										
27.	Support - diet			.08	.10	.08	.04	.06	.05	.15	.17	**.21**	.11	.14	.08	.12	.06	.08	**.22**	**.31**	**.30**	.12	.12	**.20**	.18		**.67**	1									
28.	Support - smoking	.05		.05	.10	.06	.02	.03	.05	.11	.14	.17	.08	.11	.04	.07		.05	.15	**.23**	**.22**	.09	.06	.13	.12		**.47**	**.54**	1								
29.	Support - stress	.03		.07	.09	.12		.03	.04	**.23**	**.25**	**.29**	.14	.15	.06	.14	.07	.10	**.33**	**.45**	**.45**	.17	.13	**.31**	**.21**		**.52**	**.53**	**.46**	1							
30.	Support - unwell	.03	-.03	.06	.06	.10	.03	.04	.03	.18	.19	**.24**	.12	.12	.06	.10	.05	.07	**.22**	**.36**	**.35**	.17	.19	**.26**	**.25**	-.03	**.36**	**.36**	**.30**	**.50**	1						
31.	Man. encourag.	.02		.05	.06	.08	.02	.04	.03	.16	.16	**.23**	.08	.12	.06	.09	.05	.08	**.22**	**.43**	**.35**	.13	.13	**.32**	**.24**		**.26**	**.25**	**.20**	**.36**	**.37**	1					
32.	Man. wellbeing	.02		.05	.06	.08	.02	.05	.04	.15	.15	**.22**	.08	.12	.07	.08	.03	.06	**.21**	**.40**	**.34**	.14	.13	**.30**	**.25**		**.28**	**.27**	**.22**	**.38**	**.44**	**.75**	1				
33.	Health importance	.02		.05	.06	.08		.04	.03	.18	.19	**.23**	.11	.13	.06	.11	.05	.08	**.24**	**.36**	**.37**	.13	.13	**.23**	.18	-.02	**.41**	**.40**	**.29**	**.45**	**.35**	**.29**	**.32**	1			
34.	Man. discussion			.08	.08	.09		.05	.04	**.26**	**.27**	**.29**	.13	.15	.03	.12	.05	.08	**.24**	**.32**	**.30**	.11	.09	**.28**	.14	.02	**.24**	**.24**	.19	**.34**	**.31**	**.35**	**.39**	**.29**	1		
35.	Work engagement			.09	.11	.10	.03	.08	.07	**.36**	**.35**	**.44**	.15	**.23**	.03	.16	.06	.11	**.38**	**.65**	**.38**	.13	.13	**.34**	**.22**		**.29**	**.29**	**.24**	**.37**	**.34**	**.41**	**.37**	**.33**	**.32**	1	
36.	Productivity	.03	-.04	.14	.07	.11	.03	.10	.04	**.41**	**.42**	**.33**	**.21**	**.29**	.04	**.24**	.20	**.23**	**.36**	**.25**	**.21**	.04	.04	**.26**	.15	.05	.14	.13	.08	.20	.12	.12	.10	.14	.16	**.26**	1	

Note: All coefficients shown are significant at the 0.001 level. Coefficients in bold are greater or equal than 0.2. SA = Self-assessment, PA = Physical activity.
For all variables, higher values represent preferable outcomes.

Table A7: Analysis of representativeness - descriptive statistics

	BHW		HSE	
	Mean	# obs	Mean	# obs
Gender (% male)	0.5	29,928	0.5	6,546
Age (years)	39.1	29,928	41.7	4,751
Ethnicity (white)	93%	29,928	83%	6,475
Ethnicity (Asian)	4%	29,928	10%	6,475
Ethnicity (black)	1%	29,928	4%	6,475
Ethnicity (mixed)	2%	29,928	3%	6,475
BMI	26.1	29,928	25.2	5,262
Alcohol (units per week)	11.3	29,928	10.2	4,820
% current smokers	10%	29,928	13%	6,546
Life satisfaction (1 = low - 4 = very high)	2.7	29,928	2.9	4,310

Table A8: Analysis of representativeness - regression

	BHW		HSE	
Constant	2.835	***	3.137	***
	(0.047)		(0.131)	
Gender	-0.008		0.005	
	(0.010)		(0.028)	
Age	0.006	***	0.003	**
	(0.000)		(0.001)	
Ethnicity (white)	0.169	***	0.061	
	(0.039)		(0.111)	
Ethnicity (Asian)	0.054		-0.052	
	(0.045)		(0.119)	
Ethnicity (black)	-0.013		-0.017	
	(0.056)		(0.131)	
BMI	-0.017	***	-0.012	***
	(0.001)		(0.003)	
Alcohol (units per week)	-0.001	**	-0.001	*
	(0.000)		(0.001)	
% current smokers	-0.245	***	-0.173	***
	(0.016)		(0.037)	

Note: Life satisfaction as the dependent variable.

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