Glasgow Centre for Population Health

BRIEFING PAPER 41 FINDINGS SERIES

Public health implications of the pSoBid study

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KEY POINTS

- Socioeconomic inequalities in health are essentially universal: poorer health is more common among people in less advantaged circumstances.
- The pSoBid study sought to examine associations between social deprivation and a variety of health indicators, and to incorporate a range of co-factors, with the aim of enhancing understanding of the relationships between social deprivation and ill health.
- In a cross-sectional, population-based study, participants from the extremes of socioeconomic deprivation in Glasgow attended for assessment of their medical history, lifestyle, risk factors for chronic disease, cognitive function and psychological profile, and carotid artery ultrasound. A sample of male participants also attended for MRI scanning.
- The characteristics of the least and most deprived participant groups varied across indices of adult socioeconomic status, early life conditions, health behaviours, cognitive ability and biomarkers of inflammation and carotid atherosclerosis.
- The approach employed in pSoBid has allowed for a biomedical perspective on population health and enabled a more holistic understanding of the diverse characteristics of individuals who reside in affluent and deprived communities and their influence on health and health inequalities.
- The relationship between social deprivation and health involves a complex interplay of early life factors, biological and psychological mediators which in turn affect health behaviours and health outcomes.
- pSoBid demonstrates the considerable impact of deprivation in creating and exacerbating ill health.
- Socioeconomic circumstances drive population health outcomes. Addressing poverty, deprivation and their direct consequences must therefore be a policy priority.

The final report[1] of *The psychological, social and biological determinants of ill health (pSoBid) in Glasgow: a cross-sectional, population based study* can be accessed via the GCPH website: www.gcph.co.uk.

This report presents the full background to the study, a review of relevant literature, the complete study methodology and findings to date as a series of abstracts from published academic papers.

INTRODUCTION

This Briefing Paper summarises the background, methodology and findings of the pSoBid (pronounced 'so-bid') study and discusses the findings in relation to our understanding of health inequalities, implications for population health research and implications for policy and practice.

BACKGROUND

Socioeconomic inequalities in health are essentially universal: poorer health is more common among people in less advantaged circumstances. Heart disease, diabetes, some cancers, rheumatoid arthritis and mental illness are examples of the burden of ill health that is carried disproportionately by those living in deprived communities[2-4]. Not only are the prevalence and incidence of disease higher in areas of deprivation but also the nature of the problem appears to be qualitatively different, and treatment less successful[5]. This inequality in disease risk can be partially explained by the higher prevalence of classical risk factors in deprived areas, but this explanation fails to account for the totality of the variation[6-8] and there is a need to uncover other potential explanatory variables.

There are social gradients in a range of biological and psychosocial variables which indicate that living in a more deprived area may increase the propensity to develop chronic disease, through as yet unknown mechanisms. A potential underlying cause of increased prevalence of disease is chronic inflammation[a,9,10]. This has been observed to be more common in deprived than affluent populations, linked to coronary heart disease[11], increased risk of type 2 diabetes[12] and other disorders[13], as well as cognitive dysfunction and altered psychological profiles[14-16].

These proposed aetiological links need further exploration as potential explanations of the burden of physical and mental ill health in deprived communities.

[a] Inflammation: is part of the complex biological response of vascular tissues to harmful stimuli, such as pathogens, damaged cells, or irritants, which can be acute or chronic.

THE pSoBid STUDY

The pSoBid study sought to examine the psychological, social, behavioural and biological determinants of ill health within population groups in Glasgow that differed in socioeconomic status and in their propensity to develop chronic disease, especially coronary heart disease and type 2 diabetes mellitus. The pSoBid study brought together expertise from social epidemiology, public health, biochemistry, psychology, neuroscience and genetics from the University of Glasgow, NHS Greater Glasgow and Clyde and the Glasgow Centre for Population Health, to build a better understanding of why living in poorer, more stressful circumstances results in higher levels of disease and ill health. The study sought to relate the social conditions of the population of Glasgow to their psychological profile and their biological status.

pSoBid was established and funded by the Glasgow Centre for Population Health. The research fieldwork was carried out from December 2005 to May 2007.

AIM

pSoBid was an exploratory pilot for a larger-scale investigation of the genotypic (underlying genetic) and phenotypic (observable physical and behavioural) determinants of ill health in deprived communities.

The study set out to:

- examine the associations between classical and novel risk factors and health outcomes, and to further examine the interactions between these determinants.
- assess the extent to which the gap in health outcomes can be explained by these factors.
- yield insights into new approaches which might help address Glasgow's health record.

The study also sought to ascertain the feasibility of carrying out a large-scale population study by collecting information about the response rate, drop-out rate, time taken by participants to complete the questionnaires, and any discomfort experienced in relation to the various medical assessments.

METHODOLOGY

Recruitment and sample characteristics

The selection of participants was based on the Scottish Index of Multiple Deprivation (SIMD) 2004[17], which ranks small areas on the basis of multiple deprivation indicators. Participants were recruited from five general medical practices in Glasgow that served the bottom 5% of SIMD (i.e. relatively deprived) and a further five medical practices in areas classified as being in the top 20% of the SIMD (i.e. relatively affluent). Approximately equal numbers from both areas, equal numbers of males and females and equal numbers from each of three age groups (35-44, 45-54 and 55-64 years old) were recruited. A total of 666 participants took part in the study, 342 from the least deprived areas and 324 from the most deprived. Ethical approval for the study was obtained from Glasgow Royal Infirmary Research Ethics Committee and all participants gave written informed consent.

Study protocol

Participants attended for two study visits around two weeks apart (each lasting about 90 minutes to two hours). At visit 1, participants completed lifestyle and psychological questionnaires and underwent measurement of blood pressure, heart rate, hip, waist and mid-thigh circumference and assessment of lung function. At visit 2, participants were asked to fast before attending, so bloods could be taken for biochemical analyses. Height and weight were measured. After being provided with breakfast, subjects completed a number of cognitive tests. Finally, carotid artery ultrasound, a non-invasive measure of atherosclerosis and indicator of future risk of a coronary event, was performed.

At a later date, a small number of male participants took part in the neuroimaging component of the study (visit 3) to investigate brain structure (morphology) using MRI scanning[b]. From a study total of 327 male participants, 140 volunteered, and 42 were randomly selected: 21 from the least deprived group and 21 from the most deprived group.

Study components

The lifestyle questionnaire had 13 sections including basic demographic data, past and present health status, current medications, oral health, smoking history, alcohol intake, dietary intake, physical activity levels and questions relating to early-life home circumstances and childhood (at 11 years of age) and adult (current) socioeconomic status. A number of psychological questionnaires were completed across the two study visits and included the General Health Questionnaire-28[18], the Generalised Self-Efficacy Scale[19], the Sense of Coherence Scale[20], the Beck Hopelessness Scale[21], the Rosenberg Self-esteem Scale[22] and the Eysenck Personality Questionnaire[23]. A series of cognitive tests were completed and included the Trail Making Test[24], the Stroop Test[25], the Choice Reaction Time Test[26], the Auditory Verbal Learning Test[27] and the National Adult Reading Test[28].

[b] Magnetic resonance imaging (MRI) is a medical imaging technique most commonly used to visualise detailed internal body structures that do not show up well on x-rays.

Blood samples were taken for analysis of, as a minimum, cholesterol, triglycerides, low density lipoprotein (LDL), high density lipoprotein (HDL), high sensitivity C-reactive protein (CRP), glucose, insulin, interleukin-6 (IL-6), intercellular adhesion molecule-1 (ICAM), and von Willebrand Factor (vWF).

Details of the complete study methodology, including the approaches taken for the measurement of the carotid artery intima-media thickness[c], neuroimaging, telomere length determination[d] and statistical analysis, are presented in the final study report[1].

FINDINGS

The researchers examined the associations of social deprivation with a variety of health measures, and measured a wider range of co-factors with a view to enhancing understanding of the relationships between social deprivation and ill health[29]. The study findings are presented in the final report as a series of published journal article abstracts across the psychological, social and biological determinants of health as investigated by the study team[e].

The depth and range of the data collected and the analyses undertaken yielded important information concerning the relationships between health and factors such as socioeconomic status, inflammation, atherosclerosis, mental outlook, cognitive performance and personality, early-life family circumstances, genetic disposition and brain morphology.

Overview of pSoBid study population profile: comparisons of the two study groups

Individual level indices of socioeconomic status as an adult (household income, home ownership and years in education) varied in the expected direction between the two study groups. There were also significant differences between the groups in indices of early life conditions – with participants in the group recruited from more deprived areas coming from larger families; and their fathers being more likely to be in a manual occupation and less likely to own the family home or a car.

Clear differences were seen between the most and least deprived groups in health behaviours. Almost half of participants (45%) in the deprived group were current smokers compared with only 6% of their more affluent counterparts. More deprived participants were also less physically active and had a poorer diet.

Biomarkers of chronic inflammation were higher, and lung function poorer, in the more deprived group. Surprisingly, total cholesterol was significantly lower in the deprived group and there was no difference in blood pressure between the two groups. Carotid atherosclerosis[f] was more extensive in the deprived than the affluent group.

[c] Measurement of the carotid artery wall intima-media thickness is a commonly used non-invasive marker of atherosclerosis and a reliable indicator of future risk of coronary heart disease.
[d] Telomeres are pieces of DNA at the end of chromosomes whose length is a measure of 'miles on the clock' or biological ageing. Shorter telomeres predict certain disease outcomes.
[e] References for published pSoBid journal articles can be accessed in the final report[1] and on the pSoBid page of the GCPH website[30].
[f] Carotid atherosclerosis: a narrowing or constriction of the inner surface of the carotid artery, usually caused by atherosclerosis, a condition in which the artery wall thickens as a result of the accumulation of fatty materials such as cholesterol and triglycerides.

Measures of personality indicated that participants from the more deprived areas showed higher levels of neuroticism (reflecting negative emotions including anxiety, pessimism and guilt) and psychoticism (negative emotions and perceptions including hostility and social isolation) compared with those from the affluent areas. Participants from deprived areas performed less well in cognitive performance tests. Moreover, scales assessing mental wellbeing gave poorer scores for hopelessness, self-esteem and sense of coherence[g] in participants from more deprived areas.

Participants recruited from the more deprived areas were also found to have accelerated rates of telomere attrition compared with their more affluent counterparts. Significant differences between groups in brain morphology were also identified for men[h], with participants in the deprived group having reduced grey and white matter volumes in the cerebellum.

[g] Sense of coherence: the extent to which one has a feeling of confidence that one's environment is predictable and that things will work out as well as can be reasonably expected. Reflects an individual's capacity to respond to stressful situations.
[h] Women were not involved in this part of the study. From the original study sample of 327 male participants, 140 volunteered and 42 were randomly-selected for examination.

PUBLIC HEALTH IMPLICATION OF STUDY FINDINGS

The implications of the pSoBid findings will be considered in terms of three sets of issues: how health inequalities are understood; implications for population health research; and implications for policy and practice.

Inequalities in health

Clear differences were found between those living in the most affluent circumstances and those in the poorest circumstances – and these differences are seen in almost all of the characteristics measured in this study. They exist in relation to health behaviours, mental wellbeing, psychological traits and cognitive performance, coronary heart disease risk factors, biomarkers of systemic inflammation, telomere length, DNA methylation, brain morphology, carotid atherosclerosis and early years' experiences. There may be medical, educational, social or environmental responses to each of these measures, but recognising that they all are associated with the common cause of socioeconomic deprivation is a clear reminder of the importance of refocusing efforts there. pSoBid has demonstrated the considerable impact of deprivation in creating and exacerbating ill health.

Social circumstances have direct biological consequences, as well as impacting on behaviours. Unhealthy diet, lack of exercise, tobacco and drug use has now become strongly associated with social disadvantage. Notably, material constraints, prevalent social norms and limited opportunities to make healthy choices may act as a barrier for lower socioeconomic groups to adopt healthy lifestyles[31,32]. Moreover, traditional risk factors (whether behavioural or biological) are not sufficient to explain the differences seen in health outcomes between study groups. There is the added effect of social deprivation. Hence, all other things being equal, even if the differences were abolished between social groups in smoking rates, blood pressure, inflammatory proteins and so on, differences in health outcomes would remain.

Alongside these direct outcome-specific inequalities in health sits the background process of accelerated ageing. The concept of poorer people having 'more miles on the clock' is well recognised, and results in their biological age being older than their chronological age[33]. Our findings demonstrate that the rate of age-related telomere attrition[i] is significantly associated with measures of lower socioeconomic status in individuals, and also with poor diet. More tentatively, associations with measures of inflammation also seem to be present.

As well as deprivation having an impact on an individual's own health, this study has shown that socioeconomic status is also associated with epigenetic differences[j]. DNA methylation[k] was found to be 24% lower in manual workers than in those in non-manual jobs. Through epigenetic processes, effects of the socioeconomic environment become embedded at a biological level (within the genotype) and these changes are transmissible from one generation to the next. In short, the drivers of today's health inequalities are also laying the bedrock of health inequality in subsequent generations.

[i] Age-related telomere attrition: telomeres shorten with age in all replicating somatic cells; therefore telomere dynamics (length, attrition) capture biological ageing above and beyond chronological ageing, such that shorter telomeres represent increased biological senescence.
[j] Epigenetics: the study of heritable changes in gene expression or cellular phenotype caused by mechanisms other than changes in the underlying DNA sequence.
[k] DNA methylation: a biochemical process involving the addition of a methyl group to the cytosine or adenine DNA nucleotides. DNA methylation alters the expression of genes in cells as cells divide and differentiate from stem cells into specific tissues.

Implications for population health research

pSoBid was undertaken as a pilot study, to test the feasibility of this type of population-based research incorporating a diverse range of measures and academic perspectives. From this, much has been learnt about the practicalities of undertaking research of this type. Following considerable effort, the study was successful in recruiting participants of the required sex and age profile from the most and least deprived areas of Glasgow. The involvement and co-operation of primary care services was crucial.

The study was successful in recruiting a sample of participants collectively comprising a balanced sex and age profile from the most and least deprived communities of Glasgow, and illustrates the willingness of people to volunteer for a variety of investigations involving psychological, behavioural, sociological and medical questions and tests including blood analysis. As in other studies, it was easier to recruit females than males, older compared with younger people, and more affluent participants. Linkage to medical records allowed comparison of the health characteristics of participants and non-participants, yielding an insight into aspects of volunteer bias in studies of this type.

Building on this study, there is a clear need for longitudinal studies which similarly have a focus on health inequalities and are concerned with diverse measures. These would enable conclusions to be drawn about temporal relationships – thereby making clearer the pathways through which effects occur, and also highlighting measures and biomarkers of particular value for assessing the impact of health or social policy interventions. The pSoBid findings illustrate the existence of life-course effects, and also the emergence of inequality in older age. These findings highlight the importance of not limiting research to a specific age group.

Future studies involving participants from a wider range of socioeconomic circumstances would allow the establishment of a sample population gradient, on which to test a range of hypotheses, investigate the distribution of the variables of interest, and explore whether threshold effects exist.

Lastly, this study has highlighted the importance of including measures of socioeconomic status within health research. Measures of early-life circumstances, individual socioeconomic status and area-based deprivation are all important. Just as research findings are routinely reported by gender and age, they should also routinely consider socioeconomic position.

Implications for policy and practice

Socioeconomic circumstances drive population health outcomes. Addressing poverty, deprivation and their direct consequences must therefore be a policy priority. Recognition of the impact of deprivation also needs to be an integral part of frontline service delivery. Much more can be done in both these regards. An example where the impact of deprivation has been recognised is in the revision of calculations of cardiovascular risk. Social deprivation has now been incorporated into cardiovascular risk scores, e.g. the ASSIGN Score[l], alongside classical risk factors and family history of cardiovascular disease[35]. pSoBid findings support such developments: classical cardiovascular risk factors alone do not fully explain the differences between participants from the most and least deprived areas. In addition to differences in risk, our findings suggest that public health messages directed at classical risk factors (smoking, diet and blood pressure) will be insufficient to tackle the socioeconomic gradient in cardiovascular disease incidence and prevalence.

In line with the emphasis being placed in Scotland on the importance of supporting all children to have a good start in life, this study highlights both the fact that early years' experiences continue to have an effect into adulthood (inflammation being an important mechanism) and the fact that adult circumstances will impact the next generation (through epigenetic effects). A good start in life involves attention to the parents' health and circumstances and those of the child.

Furthermore, this study has highlighted that chronic stress has a negative impact on wellbeing and cognition throughout the life-course. The current lifespan approach to research on stress and cognition emphasises the long-lasting effects of exposure to early life adversity. By reducing early life adversity it may be possible to support the development of more resilient phenotypes[m] – individuals who will be less susceptible to stress-associated cognitive disturbances/disorders in later life. This implies that efforts to reduce inequalities should continue to be broad-based, including educational opportunities and interventions directed at early life.

The relationships between socioeconomic circumstance and personality are of further interest. This study has shown that, for those in more favourable circumstances, health outcomes are better – regardless of personality characteristics. However, for those in more deprived circumstances, personality traits are significant and important predictors of mental wellbeing and health-related behaviour. To a degree, good mental wellbeing and the trait of extraversion (sociability, optimism and impulsivity) help to protect against the consequences of poorer circumstances.

These findings also suggest that it may be appropriate to consider individual personality traits and cognition levels when developing health-promotion activities, public health interventions and in the health professional-client interaction. Interventions may be more effective when they are adapted to certain personality characteristics and have a focus upon supporting and enhancing the aspects of mental wellbeing, such as sense of coherence, which have demonstrated a positive association with health. In the development of public health improvement activities and interventions, giving consideration to the role played by different personality traits, may improve uptake, sustainability, effectiveness and success.

[l] The ASSIGN score estimates a person's risk of developing cardiovascular disease[34]. It is used to identify those at high risk of having a heart attack or stroke.
[m] Phenotype: the observable characteristics or traits of an individual which result from interactions between an individual's genes and the environment.

CONCLUSIONS

The important information that pSoBid has collected on the determinants of ill health across the socioeconomic gradient in Glasgow places the study in a good position to provide insight and understanding into the links between people's social circumstances, mental wellbeing and biological markers of disease. The sample was selected from the ends of the socioeconomic gradient, and is therefore not representative of the population of interest as a whole. The cross-sectional study design also means that it is not possible to identify causal pathways or the relationships between variables, and we can therefore only report associations. Nonetheless, the multidisciplinary approach employed in pSoBid has contributed a biomedical perspective on population health and enabled a more holistic understanding of the diverse characteristics of individuals who reside in deprived and affluent communities and their influence on health and health inequalities.

The relationship between social deprivation and health presents a complex interplay of early-life factors, biological and psychological mediators which in turn affect health behaviours and subsequent health outcomes. The apparently complex nature of these relationships suggests that solutions to the widening gap in health inequalities are also likely to be complex. pSoBid findings highlight the need for factors such as early life circumstances and personality to be taken into account as well as the more the classically-recognised factors such as smoking, diet, cholesterol and blood pressure. This is crucial if we are to stand a chance of narrowing the health gap between the most and least deprived in society.

Inequalities in health matter. The relationship between socioeconomic position and mortality is strikingly consistent. Despite the well-documented simplicity of the association between social position and health outcomes, more complex questions remain about the mechanisms through which such associations arise and how amenable they are to change through intervention. pSoBid has highlighted and reinforced the complex and multifactorial nature of socioeconomic inequalities in health. Future interventions need to be based on the best possible evidence about the many complex and inter-related factors that generate and maintain social and health inequalities, and the greatest gains in advancing population health will, predictably, result from investment to improve social and economic conditions in both early and later life.

REFERENCES

[1] Glasgow Centre for Population Health. *Psychological, social and biological determinants of ill health (pSoBid) in Glasgow: a cross-sectional, population-based study*. Final study report. Glasgow: GCPH; 2013. Available at: http://www.gcph.co.uk/publications/421_psychological_social_and_biological_determinants_of_ill_health_psobid?&&aq=psobid (accessed April 2014).

[2] Davey Smith G. Socioeconomic differentials. In: Kuh D, Shlomo YB (eds.) *A life course approach to chronic disease epidemiology*. Oxford: Oxford University Press; 1997.

[3] Mackenbach JP, Bos V, Andersen O, Cardano M, Costa G, Harding S, Reid A, Hemström O, Valkonen T, Kunst AE. Widening socioeconomic inequalities in mortality in six Western European countries. *International Journal of Epidemiology* 2003;32(5):830-837.

[4] Marmot MG. Social determinants of health. *The Lancet* 2005;365(9464):1099-1104.

[5] Ionescu MV, Carey F, Tait IS, Steele RJ. Socioeconomic status and stage at presentation of colorectal cancer. *The Lancet* 1998;352(9138):1439.

[6] Shewry MC, Smith WC, Woodward M, Tunstall-Pedoe H. Variation in coronary risk factors by social status: results from the Scottish Heart Health Study. *British Journal of General Practice* 1992;42(363):406-410.

[7] Tunstall-Pedoe H, Woodward M, Tavendale R, A'Brook R, McCluskey MK. Comparison of the prediction by 27 different factors of coronary heart disease and death in men and women of the Scottish Heart Health Study: cohort study. *British Medical Journal* 1997;315(7110):722-729.

[8] Capewell S, Morrison CE, McMurray JJ. Contribution of modern cardiovascular treatment and risk factor changes to the decline in coronary heart disease mortality in Scotland between 1975 and 1994. *Heart* 1999;81(4):380-386.

[9] Steptoe A, Owen N, Kunz-Ebrecht S, Mohamed-Ali V. Inflammatory cytokines, socioeconomic status, and acute stress responsivity. *Brain Behavior and Immunity* 2002;16(6):774-784.

[10] Owen N, Poulton T, Hay FC, Mohamed-Ali V, Steptoe A. Socioeconomic status, C-reactive protein, immune factors, and responses to acute mental stress. *Brain Behavior and Immunity* 2003;17(4):286-295.

[11] Ross R. Atherosclerosis – an inflammatory disease. *New England Journal of Medicine* 1999;340(2):115-126.

[12] Stern MP. Diabetes and cardiovascular disease. The "common soil" hypothesis. *Diabetes* 1995;44(4):369-374.

[13] Sattar N, McCarey DW, Capell H, McInnes IB. Explaining how "high-grade" systemic inflammation accelerates vascular risk in rheumatoid arthritis. *Circulation* 2003;108(24):2957-2963.

[14] Weaver JD, Huang MH, Albert M, Harris T, Rowe JW, Seeman TE. Interleukin-6 and risk of cognitive decline: MacArthur studies of successful aging. *Neurology* 2002;59(3):371-378.

[15] Yaffe K, Lindquist K, Penninx BW, Simonsick EM, Pahor M, Kritchevsky S, Launer L, Kuller L, Rubin S, Harris T. Inflammatory markers and cognition in well-functioning African-American and white elders. *Neurology* 2003;61(1):76-80.

[16] Schram MT, Euser SM, de Craen AJ, Witteman JC, Frölich M, Hofman A, Jolles J, Breteler MM, Westendorp RG. Systemic markers of inflammation and cognitive decline in old age. *Journal of the American Geriatric Society* 2007;55(5):708-716.

[17] Scottish Index for Multiple Deprivation. Available at: http://www.scotland.gov.uk/Topics/Statistics/SIMD (accessed July 2013)

[18] Goldberg DP. *The detection of psychiatric illness by questionnaire*. Oxford: Oxford University Press; 1972.

[19] Johnston M, Wright SJ, Weinman J. *Generalised self-efficacy scale*. Measures in health psychology: a user's portfolio. Windsor: NFER-Nelson; 1995.

[20] Antonovsky A. The structure and properties of the sense of coherence scale. *Social Science and Medicine* 1993;36(6):725-733.

[21] Beck TA, Steer RA. *Beck Hopelessness Scale*. London: Harcourt Assessment; 2007.

[22] Rosenberg M. *Society and the adolescent self-image*. Princeton, NJ: Princeton University Press; 1965.

[23] Eysenck HJ, Eysenck SBG. *Manual of the Eysenck Personality Scales*. London: Hodder and Stoughton; 1991.

[24] Reitan RM, Wolfson D. Category test and trail making test as measures of frontal lobe functions. *The Clinical Neuropsychologist* 1995;9(1):50-56.

[25] Trenerry MR, Crosson B, DeBoe J, Leber WR. *Stroop Neuropsychological Screening Test*. Odessa, FL: Psychological Assessment Resources; 1989.

[26] Hope AT, Woolman PS, Gray WM, Asbury AJ, Millar K. A system for psychomotor evaluation: design, implementation and practice effects in volunteers. *Anaesthesia* 1998;53(6):545-550.

[27] Taylor EM. *Psychological appraisal of children with cerebral deficits*. Cambridge, MA: Harvard University Press; 1959.

[28] Nelson HE, Willison J. *National Adult Reading Test (NART): test manual.* Windsor, UK: NFER-Nelson; 1991.

[29] Deans KA. *Psychological and biological determinants of ill health in relation to deprivation.* PhD Thesis. Glasgow: College of Medicine, Veterinary and Life Sciences, University of Glasgow; 2011.

[30] Glasgow Centre for Population Health. *pSoBid*. http://www.gcph.co.uk/work_themes/additional_work/psobid (accessed February 2014).

[31] Wardle J, Steptoe A. Socioeconomic differences in attitudes and beliefs about healthy lifestyles. *Journal of Epidemiology and Community Health* 2003;57(6):440-443.

[32] Stringhini S, Dugravot A, Shipley M, Goldberg M, Zins M, Kivimaki M, Marmot M, Sabia S, Singh-Manoux A. Health behaviours, socioeconomic status and mortality: further analyses of the British Whitehall II and the French GAZEL prospective cohorts. *PLoS Medicine* 2011;8(2):e1000419.

[33] Lamb JK, Shiels PG. Telomeres, ageing and oxidation. *SEB Experimental Biology Series* 2009;62:117-137.

[34] The ASSIGN Score. Available at: http://assign-score.com/ (accessed February 2014).

[35] Woodward M, Brindle P, Tunstall-Pedoe H. SIGN group on risk estimation. Adding social deprivation and family history to the cardiovascular risk assessment: the ASSIGN score from the Scottish Heart Health Extended Cohort (SHHEC). *Heart* 2007;93(2):172-176.

pSoBid STUDY TEAM

The pSoBid study team are:

University of Glasgow

- Prof Keith Millar
- Prof Naveed Sattar
- Dr Jonathan Cavanagh
- Dr Paul Shiels

The Robertson Centre for Biostatistics, University of Glasgow

- Prof Ian Ford
- Ms Sharon Kean
- Dr Alex McConnachie
- Vladimir Bezylak, Claudia-Martina Messow, Paul Johnson, Suzanne Lloyd

NHS Greater Glasgow and Clyde

- Prof Chris Packard (Study Principal Investigator)
- Dr Kevin Deans
- Sister Agnes McGinty

Medical Research Council, Social and Public Health Sciences Unit

- Dr G David Batty

Scottish Government

- Dr Sir Harry Burns, Chief Medical Officer

Glasgow Centre for Population Health

- Prof Carol Tannahill
- Dr Yoga Velupillai (Study Project Manager 2004-2008)
- Dr Jennifer McLean (Study Project Manager 2009-2014)

CONTACT

Dr Jennifer McLean
Public Health Programme Manager

Glasgow Centre for Population Health
1st Floor, House 6
94 Elmbank Street
Glasgow
G2 4NE

Tel: 0141 287 6959
Email: Jennifer.McLean@drs.glasgow.gov.uk
Web: www.gcph.co.uk