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Socioeconomic position, gender, health behaviours and biomarkers of cardiovascular disease and diabetes

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ABSTRACT

Socio-economic gradients in cardiovascular disease (CVD) and diabetes have been found throughout the developed world and there is some evidence to suggest that these gradients may be steeper for women. Research on social gradients in biological risk factors for CVD and diabetes has received less attention and we do not know the extent to which gradients in biomarkers vary for men and women.

We examined the associations between two indicators of socio-economic position (education and household income) and biomarkers of diabetes and cardiovascular disease (CVD) for men and women in a national, population-based study of 11,247 Australian adults. Multi-level linear regression was used to assess associations between education and income and glucose tolerance, dyslipidaemia, blood pressure (BP) and waist circumference before and after adjustment for behaviours (diet, smoking, physical activity, TV viewing time, and alcohol use). Measures of glucose tolerance included fasting plasma glucose and insulin and the results of a glucose tolerance test (2 h glucose) with higher levels of each indicating poorer glucose tolerance. Triglycerides and High Density Lipoprotein (HDL) Cholesterol were used as measures of dyslipidaemia with higher levels of the former and lower levels of the later being associated with CVD risk.

Lower education and low income were associated with higher levels of fasting insulin, triglycerides and waist circumference in women. Women with low education had higher systolic and diastolic BP and low income women had higher 2 h glucose and lower HDL cholesterol. With only one exception (low income and systolic BP), all of these estimates were reduced by more than 20% when behavioural risk factors were included. Men with lower education had higher fasting plasma glucose, 2 h glucose, waist circumference and systolic BP and, with the exception of waist circumference, all of these estimates were reduced when health behaviours were included in the models. While low income was associated with higher levels of 2-h glucose and triglycerides it was also associated with better biomarker profiles including lower insulin, waist circumference and diastolic BP. We conclude that low socio-economic position is more consistently associated with a worse profile of biomarkers for CVD and diabetes for women.

In developed countries cardiovascular disease (CVD) and diabetes are major contributors to the overall burden of disease and socio-economically disadvantaged groups have higher rates of morbidity and mortality from these conditions (Agardh, Ahlbom et al. 2007; Maty, Everson-Rose et al. 2005; Thurston, Kubzansky et al. 2005). Socio-economic position (SEP) may influence CVD and diabetes risk through a number of mechanisms operating across the life course. Early in life, childhood socio-economic circumstances may influence childhood nutrition, behaviours and illness as well as shape fetal exposures such as to poor maternal nutrition. All of these might contribute to adult CVD and diabetes risk. In adult life adult SEP could influence biological risk factors for CVD and diabetes (e.g. cholesterol) through a range of factors including health behaviours and psychosocial conditions. Socio-

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economic differences in access and uptake of health services (e.g. anti-hypertensive medications) and behavioural risk factor modification may affect the progression from biological risk factors to clinical disease. Our focus in this paper is to better understand the relationships between adult SEP and biological risk factors for CVD and diabetes and to explore the extent to which these associations are independent of health behaviours.

Our rationale for investigating the role of health behaviours stems from the known associations between health behaviours (e.g. physical activity, diet and smoking) and: 1) CVD and diabetes (Agardh, Ahlbom et al. 2004; Kahn, Robertson et al. 2008), 2) biomarkers of CVD and diabetes including evidence regarding physical activity and glucose metabolism (Healy, PZ et al., 2006); smoking and blood pressure (BP) and dyslipidaemias (Lee, Park et al. 1998); increased alcohol and BP, glucose tolerance and HDL cholesterol (Lee, Park et al. 1998); energy intake and serum cholesterol levels (Sonnenberg, Posner et al. 1992) and sedentary behaviour and glucose tolerance (Dunstan, Salmon et al. 2004) and dyslipidaemia (Healy, Dunstan et al. 2008). Finally, previous research has demonstrated that health behaviours explain some of the socio-economic gradient observed for these diseases (Agardh, Ahlbom et al. 2004; LinksStrand & Tverdal, 2004)

SEP and biomarkers of CVD and diabetes

There have been a number of studies that have examined associations between one or more markers of SEP and metabolic syndrome (defined as a clustering of the biomarkers that are associated with between 1.5 and three times the risk of CVD and type 2 diabetes (Alberti, Zimmet et al. 2006) or the components of metabolic syndrome including waist circumference, blood pressure (BP), triglycerides, HDL cholesterol, fasting or 2-h glucose and fasting insulin. We limit our discussion to 27 studies from developed countries, with participants of working age, who did not have diagnoses of CVD or diabetes (see Supplementary Table 1) however it should be noted that socio-economic inequalities in CVD and diabetes biomarkers have also been found in resource-poor countries (THUSA study et al.). Together, the studies provide strong evidence that low SEP is associated with a poorer biomarker profile. However, the associations differ according to the measure of SEP (income, education, occupation, housing tenure and car ownership) and the specific biomarker tested. In 17 studies the results were presented separately for men and women or interactions were tested; in 12 of these studies the gradients appeared to be stronger and/or were found over a larger range of biomarkers for women (Chichlowska, Rose et al. 2008; Hart, Ecob et al. 1997; Loucks, Rehkopf et al. 2007; Luepker, Rosamond et al. 1993; Merlo, Asplund et al. 2004; Myint, Luben et al. 2006; Myllykangas, Pekkanen et al. 1995; Power, Matthews et al. 1998; Santos, Ebrahim et al. 2008; Shewry, Smith et al. 1992; Sorel, Ragland et al. 1992). Nine of the 27 studies assessed whether health behaviours mediated associations between SEP and biomarkers (Chichlowska, Rose et al. 2008; De Vogli, Brunner et al. 2007; Ishizaki, Yamada et al. 1999; Loucks, Rehkopf et al. 2007; Loucks, Magnusson et al. 2007; Merlo, Asplund et al. 2004; Santos, Ebrahim et al. 2008; Schroder, Rohlfs et al. 2004; Silventoinen, Pankow et al. 2005). These studies found evidence that gradients for metabolic syndrome (a clustering of biological risk factors associated with a substantially increased risk of diabetes and CVD) (De Vogli, Brunner et al. 2007; Loucks, Magnusson et al. 2007; Loucks, Rehkopf et al. 2007; Silventoinen, Pankow et al. 2005), HDL cholesterol (Loucks, Rehkopf et al. 2007; Schroder, Rohlfs et al. 2004); LDL cholesterol (Schroder, Rohlfs et al. 2004), systolic and diastolic BP(Schroder, Rohlfs et al. 2004) and waist circumference (Loucks, Rehkopf et al. 2007; Schroder, Rohlfs et al. 2004) were attenuated by inclusion of health behaviours in models with SEP. In the studies by Loucks et al. however, behaviours were only important in explaining SEP gradients for women (Loucks, Magnusson et al. 2007; Loucks, Rehkopf et al. 2007). Interestingly, some studies from resource-poor settings also support the possibility of stronger SEP gradients for women compared with men in biomarkers (Medez, Cooper R, Wilks, Luke, Forrester, 2003; Minh, Byass, Chuc, & Wall, 2006). These studies raise the possibility that SEP may influence biomarkers in gender-specific ways and through gender-specific pathways.

A range of methodological issues threaten the quality of the findings reported from these studies, including: limited measures of SEP, such as dichotomous measure of education and income (Muennig, Sohler et al. 2007); a small number of biological outcomes; a large proportion of missing information on socio-economic variables particularly income (Loucks, Rehkopf et al. 2007; Pekkanen, Tuomilehto et al. 1995; Seeman, Merkin et al. 2008)) and biomarkers (Loucks, Rehkopf et al. 2007); and, selective samples of work environments (Brunner, Wunsch et al. 2001; De Vogli, Brunner et al. 2007; Heslop, Smith et al. 2001; Ishizaki, Yamada et al. 1999)). In addition, many of the studies dichotomised the biomarkers as below or above a certain threshold as abnormal (e.g. defined as glucose intolerant) when increased risk of CVD and diabetes may be experienced even at levels below these cut-points. For example, elevated fasting and 2-h plasma glucose levels below the cut-off for diabetes are associated with an increased risk of CVD (Coutlinho, Gerstein et al. 1999).

Evidence from high-quality population-based studies regarding the associations between SEP and biomarkers and the potential role of health behaviours in explaining inequalities is urgently needed in order to assess the potential for primary prevention strategies targeted at reducing inequalities. Further, understanding how gender interacts with SEP to shape biomarker outcomes is critical as intervention strategies may need to be gender specific or at least take gender into account. First, there is a considerable literature describing the gender biases in some measures of adult SEP, particularly occupation, where classification systems are usually weighted toward traditionally male occupations and thus better differentiate the occupational status of men (Annandale & Hunt, 2000). Alternatively, as Krieger et al. have argued, women's occupational status has often been based on their male partner's occupation rather than their own (Krall, Valadian et al. 1988; Krieger & Fee, 1994; Krieger, Barbeau et al. 2005; Krieger, Chen et al. 1999). Second, for a given level of SEP men and women may have access to different material and non-material resources. For example, it is known that while women in developed countries, such as Australia, achieve equal or better levels of education as men this does not translate into the equivalent status jobs or income (Bobbitt-Zeher, 2007) Based on this, one might anticipate that education may have a weaker association with health for women than men. Thirdly, women deploy the benefits of high SEP or experience the consequences of low SEP in different ways, For example, Broom has argued in relation to obesity, it is possible that men and women use their socio-economic resources to invest in 'goods and services' differently; women may be more likely use their income to purchase high-quality diets and resources to promote physical activity while men with high incomes may be more likely to be in sedentary employment working long hours (Broom, 2008). Understanding the gender-specific associations and pathways between SEP and biomarkers will aid the development of appropriate (perhaps gender-specific) interventions to reduce socio-economic inequalities in diabetes and CVD.

Using data from over 11,000 adult Australians as part of the largest population-based prevalence survey of diabetes and pre-diabetes ever conducted in a developed country we investigate the