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AREA DEPRIVATION AND CARDIOVASCULAR RISK

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ABSTRACT

Socioeconomic status (SES) strongly impacts cardiovascular health. Increasing evidence demonstrated area deprivation is an independent indicator of cardiovascular risks such as increased prevalence of cardiovascular risk factors and higher cardiovascular disease (CVD) mortality rates. Intervention at area-level of SES could achieve better effects in reducing risk factors and improving access to cardiac facilities. Application of Geographic modelling techniques would be useful in identifying geographic variations in risk factors and inequality access to cardiac facilities in the deprived areas. However, the interactions and dynamics changes among various SES indicators and CVD outcomes during the life course require further research.

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INTRODUCTION

Cardiovascular disease (CVD), including coronary heart disease (CHD) and stroke, is the leading cause of death and disease burden globally (Roth, Huffman *et al*., 2015). Socioeconomic status (SES) is a major contributor of morbidity and mortality of cardiovascular disease (CVD) (Schultz, Kelli *et al*., 2018). The disparities of CVD among different SES status could be explained by a range of factors including higher prevalence of cardiovascular risk factors, inequality in access to health facilities for guideline-recommended treatment and preventive care, such as percutaneous coronary intervention (PCI), attending Cardiac Rehabilitation (CR) (Schroder, Richter *et al*., 2016, Arnett, Blumenthal *et al*., 2019). Such disparities can be mediated by multiple level approach encompassing the characteristics of the individual, healthcare systems and communities and are further impacted by local and national healthcare policies (Shay, Gooding *et al*., 2015, Schroder, Richter *et al*., 2016).

However, the mechanisms between SES and CVD risk are less clear.SES comprises various indicators varying between country and culture (Schultz, Kelli *et al*., 2018). The most common measurements for SES are individual-level factors including education, income, occupation and area-level factors, such as geographical or neighbourhood setting (Schultz, Kelli *et al*., 2018).The association between SES and CVD risk is well established by using individual-level measurements in high-income countries. For example, a systematic review that examined socioeconomic inequalities in the incidence of acute myocardial infarction (AMI) among 70 studies showed excess incidence of AMI was consistently evident in people with lower level of income (71%), education (34%) and occupational status (35%) compared with those with higher SES (Manrique-Garcia, Sidorchuk *et al*., 2011). A recent meta-analysis of more than 1.7 million people from 7 high-income countries showed a strong association between lower occupational status and premature CVD mortality (Stringhini, Carmeli *et al*., 2017).CVD risk is also associated with worse household economic hardship for patients after an event (Hyun, Essue *et al*., 2016).

Emerging evidence demonstrated area deprivation is an independent predictor of major adverse cardiovascular events (MACEs) and in-hospital mortality after AMI (Bergstrom, Redfors *et al*., 2015, Biswas, Andrianopoulos *et al*., 2019) despite equal quality of in-hospital care delivered to people across different areas. Better understanding SES at different levels in relation to CVD risk and risk stratification is important when relocating resource and improving quality of care (Schultz, Kelli *et al*., 2018). Therefore, the aim of this paper is to review current knowledge on the impact of SES on CVD risks in high income countries and suggest the potential interventions to reduce the disparities in CVD with focus on area-level SES.

Area-level SES: Area-level SES that include physical and social environmental characteristics play an important role in the development of CVD. The area-level SES often refers to geographic setting that differs in the size of areas, which can be larger area such as regions, or smaller areas such as neighbourhoods within the same city (Bergstrom, Redfors *et al*., 2015). Strong evidence demonstrated neighbourhood deprivation and geographical remoteness are associated with high prevalence of cardiovascular risk factors and greater risk of CVD mortality, which are independent of individual-level SES (Ramsay, Morris *et al*., 2015, Toms, Bonney *et al*., 2019). A meta-analysis of over 1 million CVD events found area deprivation was associated with increased incidence of CVD and such risk was greater in women (RRR1.75, 1.55-1.98) from deprived area than men (RRR 1.60, 1.45-1.76) (Backholer, Peters *et al*., 2017). The findings were supported by a recent systematic review which demonstrated consistent association between area deprivation and higher prevalence of cardiovascular risk factors, particularly type 2 diabetes and high body mass index (BMI) (Toms, Bonney *et al*., 2019).

Although there is lack of systematic review that examines the impact of area deprivation on CVD mortality, several studies showed the risks of CVD mortality in people from more disadvantaged neighbourhood were 1.3 to 1.9 times greater than those from less disadvantaged neighbourhood(Ramsay, Morris *et al*., 2015). Contemporary evidence from several large registry studies found area deprivation is a significant factor for in-hospital morality and adverse events after AMI along with increased length of hospitalisation and cost that persisted after adjusting for clinical risk factors and individual SES in high income countries (Barnard, Grant *et al*., 2015, Bergstrom, Redfors *et al*., 2015, Matata, Shaw *et al*., 2016, Udell, Desai *et al*., 2018).

Cardiovascular risk factors and area-level SES: Controlling modifiable risk factors is the main contributor to the reduction of CVD mortality (Schroder, Richter *et al*., 2016). This is particularly important in the primary and secondary prevention of CVD. Cardiovascular risk factors account for over 50% of the association between SES and CVD mortality and morbidity (Manrique-Garcia, Sidorchuk *et al*., 2011, Stringhini, Carmeli *et al*., 2017). Higher prevalence of cardiovascular risk factors is strongly associated with both individual and area-level SES (Toms, Bonney *et al*., 2019). However, interventions to reduce cardiovascular risk factors at the individual level were shown to have limited success (Toms, Bonney *et al*., 2019). It is suggested actions at area-level of SES including physical and social environmental characteristics could have better effects in reducing risk factors (Diez Roux and Mair 2010, Arnett, Blumenthal *et al*., 2019). This is particularly relevant to the so called "obesogenic environment", which has been related to the areas where people live, work, leisure, transport and availability of healthy food stores (Pagano, Freemantle *et al*., 2009). People living in disadvantaged neighbourhoods were less likely to access affordable healthy foods and were more likely to develop obesity (Dubowitz, Zenk *et al*., 2015). Recent longitudinal studies demonstrated that neighbourhoods with easy access to physical activity resources improved cardiovascular risk factors over time (Muller-Riemenschneider, Pereira *et al*., 2013, Creatore, Glazier *et al*., 2016).

Other impacts of area-level SES on CVD: Differences in cardiac outcomes in people with low SES may be partially driven by disparities in standard of care (Schroder, Richter *et al*., 2016, Schultz, Kelli *et al*., 2018). A systematic review found inequalities access to treatment for coronary heart disease (CHD) is more likely associated with individual-level of SES reflecting the lack of awareness of treatment options and lower health literacy level (Schroder, Richter *et al*., 2016). Area deprivation has been shown to be associated with lower access rates to CR after discharge from hospitals which is related to the distance to travel from home to a rehabilitation centre and transportation issues (Shanmugasegaram, Oh *et al*., 2013).

Although people from disadvantaged neighbourhood were shown to receive the similar quality of in-hospital care including cardiac procedures and pharmacological treatment for CHD compared to those from less disadvantaged neighbourhood (Schroder, Richter *et al*., 2016), they experience greater risk of in-hospital complications such as major bleeding, cardiogenic shock, heart failure indicating late presentation to the hospitals (Barnard, Grant *et al*., 2015, Udell, Desai *et al*., 2018).Similarly, for patients with acute coronary syndrome, comparable provision of angiogram, revascularisation, medication and referral to cardiac rehabilitation was found, but people from the most disadvantaged areas were 37% more likely to have MACEs compared to those from the least disadvantaged areas(Hyun, Redfern *et al*., 2018).

A study of nearly 400, 000 patients with AMI in USA found people from disadvantaged areas received thrombolytic therapy at a nearly 4-fold higher rate compared with those from affluent areas (Udell, Desai *et al*., 2018). An Australia study found higher proportion of patients from derived area presented to a health facility without PIC services and were more likely to receive fibrinolysis therapy for initial management of AMI compared with those from less deprived area (Biswas, Andrianopoulos *et al*., 2019). Higher rates of using thrombolytic therapy is related to greater risk of major bleeding after cardiac procedures leading to longer stay in hospital and more complications (Udell, Desai *et al*., 2018). Such observations are consistent with previous study suggesting the outcomes after AMI is strongly influenced by the location and availability of cardiac facilities in the community (Clark, Coffee *et al*., 2012, Udell, Desai *et al*., 2018). Taken together, evidence highlights there is pressing need to develop the strategies to reduce the care gaps among these most vulnerable population (Udell, Desai *et al*., 2018).Future research could consider including SES, particularly area deprivation into risk predication models (Arnett, Blumenthal *et al*., 2019).

Public health programs and interventions to increase awareness about CVD need to be implemented, particularly in the disadvantaged neighbourhood.

The potential of geographic and spatial analysis: Geographic Information System (GIS) and spatial analysis through linking local data such as postcode and health facilities has been demonstrated as a power tool to inform improved health care policy and delivery of care (Clark, Coffee *et al*., 2012, Toms, Bonney *et al*., 2019). Using GIS and spatial analysis of area-level data are effective in reporting geographic variation in cardiovascular risk factors (Toms, Bonney *et al*., 2019). Geocoding and mapping are also useful tools in identifying inequality in access to cardiac facility before and after a cardiac event in deprived neighbourhoods (Clark, Coffee *et al*., 2012). Using mobile technology or electronic social media is shown to improve access to CR in disadvantaged areas (Arnett, Blumenthal *et al*., 2019).

CONCLUSION

There is clear evidence suggesting that SES is a strong indicator of poor cardiovascular health. However, the interactions and dynamics changes among various SES indicators and CVD outcomes during the life course remained unclear and require further research (Schultz, Kelli *et al*., 2018). Further, the extent to which area-level deprivation in cardiac outcomes are reflective of the effect of individual-level SES inequalities is largely unknown. Future research could consider using hierarchical multilevel analyses to yield a comprehensive picture of the contextual aspect of CVD risk in people with lower SES (Toms, Bonney *et al*., 2019). Both qualitative and quantitative research may provide a better understanding of how area and individual-level SES influence the health behaviours and risk factors.

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