



Physical activity, healthy lifestyle behaviors, neighborhood environment characteristics and social support among Australian Aboriginal and non-Aboriginal adults

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ABSTRACT

Physical inactivity is the third leading cause of the burden of disease for Australian Aboriginal adults. The neighborhood environment and social support are known to influence physical activity (PA) participation. This study examined these factors in relation to achieving PA recommendations in Aboriginal and non-Aboriginal Australians. Cross-sectional data from the 2010 Social, Economic, and Environmental Factor (SEEF) Study in New South Wales, Australia were used to estimate adjusted odds ratios (OR) for Aboriginal versus non-Aboriginal participants for PA-related attributes, including achieving PA recommendations. ORs for achieving PA recommendations were estimated in both groups. Overall, 63.1% of Aboriginal ($n = 314$) and 65.4% of non-Aboriginal ($n = 59,175$) participants met PA recommendations. Odds of healthy sleep duration were lower, and receiving GP advice to be active was higher, among Aboriginal versus non-Aboriginal participants. Aboriginal respondents had higher odds of reporting that the crime rate made it unsafe to walk and that local public transport was inaccessible. They had higher odds of disagreeing they have local shops, footpaths or free/low cost recreation facilities. PA correlates were similar in both groups. The factors relating to PA were similar in Aboriginal and non-Aboriginal people. Neighborhood and social features were less PA-favorable for Aboriginal participants suggesting multiple possible avenues for increasing PA in this older population group.

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Introduction

Physical inactivity is the third leading cause of the burden of disease for Australian Aboriginal and Torres Strait Islander* adults (Vos et al., 2007). In 2011–2, only 46% of Aboriginal people aged 18 years and over living in non-remote areas achieved the minimum recommendation of 150 min of moderate intensity physical activity per week (Australian Bureau of Statistics (ABS), 2013a); 10% less likely to meet recommendations than their non-Aboriginal counterparts (Australian Bureau of Statistics (ABS), 2014a). Physical activity confers numerous health benefits including reducing the risk of non-communicable diseases such as cardiovascular disease, diabetes, hypertension, obesity and some cancers (World Health Organization, 2009). It can also

contribute to the prevention and treatment of many mental health and age-related disorders (Steinmo et al., 2014; Norton et al., 2014).

Australia's Physical Activity & Sedentary Behavior Guidelines for Adults (18–64 years) recommend the accumulation of 150 to 300 min of moderate intensity physical activity or 75 to 150 min of vigorous intensity physical activity, or an equivalent combination of both moderate and vigorous activities, each week (MVPA). They also recommend reducing the amount of time spent sitting and breaking up periods of prolonged sitting. Sitting time has emerged as a risk factor for chronic disease and mortality, independent of physical activity (Chau et al., 2013). Time spent watching television (TV) is often used as a measurement indicator for sedentary behavior (Clark et al., 2009).

In the general population, physical activity levels are lower among older adults, females, disadvantaged populations and rural residents (Australian Bureau of Statistics (ABS), 2013a) (Australian Institute of Health and Welfare, 2008). Aspects of the neighborhood built environment are known to have a strong influence on physical activity participation, particularly walking and cycling (Saelens et al., 2003). Higher street connectivity and the presence of neighborhood destinations (such as shops) are associated with more frequent walking for transport

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(Koohsari et al., 2014). A review identified a positive relationship between parks and recreation settings and physical activity participation (Abercrombie et al., 2008). Fear of crime has also been found to lead to a decrease in time spent walking (Foster et al., 2014).

** The term 'Aboriginal' will be used to refer to participants of Aboriginal and/or Torres Strait Islander origin, in keeping with advice from the Aboriginal Health and Medical Research Council.*

Identifying the factors associated with physical activity is important in devising strategies to increase levels of physical activity among Aboriginal people. There is little evidence regarding environmental correlates of physical activity among Aboriginal Australians. Internationally, a study of Native American elders found that being closer to interesting places was a facilitator to walking (Sawchuk et al., 2011). However, another Native American study found undesirable aspects of the built environment such as a lack of destinations for walking or public open space as barriers to walking for recreation and transport (Mathews et al., 2010). The majority of Aboriginal Australians live in urban locations (Australian Bureau of Statistics (ABS), 2011). Therefore, these aspects of the neighborhood built environment may serve to influence their levels of physical activity. However, the impact of specific historical factors such as colonisation and displacement may be a determinant of the types and quality of neighborhoods where Aboriginal Australians currently reside. To our knowledge no study has yet examined the evidence of the influence of the neighborhood built environment on physical activity levels among Australian Aboriginal people.

Social support of family and friends has been identified as a positive correlate of physical activity across various population groups, including ethnic minorities and women (Harvey and Alexander, 2012; Wilcox et al., 2009), and specifically Native American women (Henderson and Ainsworth, 2003). However, cultural traditions of Aboriginal Australians such as kinship place great importance on family and community values. Family engagement and group activities have been found to be strong motivators of physical activity participation among Aboriginal Australians (Hunt et al., 2008). We hypothesize that social support would be associated with physical activity among Aboriginal adults.

The aim of this study was to investigate the sociodemographic factors, attributes of the neighborhood built environment and social support associated with achieving the national physical activity recommendations among Aboriginal and non-Aboriginal participants of a large Australian cohort study.

Methods

Participant recruitment

The Sax Institute's 45 and Up Study is a large-scale population-based cohort study of men and women aged 45 years and older residing in New South Wales (NSW), Australia (Collaborators, 2008). Participants were randomly sampled through the Medicare database, with oversampling in rural areas and among older adults (Collaborators, 2008). Baseline self-administered postal questionnaires were distributed between 1 January 2006 and 31 December 2008. Joining the study involved completing the baseline questionnaire and providing written consent. The Social, Economic, and Environmental Factor (SEEF) study is a subsequent sub-study of the 45 and Up Study which aims to identify how social, economic and environmental factors influence the health and wellbeing of middle aged and older Australians. In 2010 the SEEF questionnaire was distributed by mail to the first 100,000 participants to join the 45 and Up Study. A total of 60,404 participants returned a completed questionnaire and a signed consent form (response rate = 60.4%).

The 45 and Up Study was granted ethical approval by the University of New South Wales Human Research Ethics Committee (Reference

050,035). The SEEF Study was granted ethical approval by the University of Sydney Human Research Ethics Committee (Ref no.: 10–2009/12,187). Ethical approval for the current study was also granted by the Aboriginal Health and Medical Research Council of New South Wales (reference 912/13).

Measures

Pilot testing of the SEEF questionnaire (n = 128) resulted in overall acceptable test–retest reliability intra-class coefficients (ICC) ranging from 0.33 to 0.84 and Cronbach's alpha coefficients ranging from 0.23 to 0.96. Aboriginal status was self-identified in the 45 and Up Study with the following question: 'Are you of Aboriginal or Torres Strait Islander Origin?' and response options of: 1) No – non-Aboriginal; 2) Yes – Aboriginal; and 3) Yes – Torres Strait Islander. Participants were able to identify as both Aboriginal and Torres Strait Islander. Very few participants indicated they were exclusively of Torres Strait Islander origin (n = 19) and for the purposes of these analyses this variable was dichotomised into non-Aboriginal and Aboriginal and/or Torres Strait Islander, with the latter category referred to as 'Aboriginal'.

Physical activity

The main outcome variable, achieving the national physical activity recommendations, was calculated based on the Active Australia Survey (AIHW, 2003) which measures minutes of walking and other moderate and vigorous leisure-time physical activity in the past week, and has acceptable reliability (Brown et al., 2004a) and validity (Timperio et al., 2003). The SEEF questionnaire included questions about the frequency and duration of their time spent doing walking, moderate and vigorous activities in the past week. Two different thresholds of at least 150 min per week and at least 300 min per week of MVPA were used, based on the upper and lower thresholds of the range advised in the national guidelines (Australian Government Department of Health, 2013).

Socio-demographic variables

Sociodemographic variables (age, sex and annual household income) were derived from the SEEF questionnaire. Educational qualifications were derived from the baseline 45 & Up Study questionnaire and dichotomised as (None/school/intermediate/High School Certificate (HSC); trade/apprenticeship/certificate/diploma/university). The Accessibility Remoteness Index of Australia Plus (ARIA+) score (AIHW, 2004) and the measure of Socio-Economic Indices for Areas (SEIFA), the Index of Relative Socio-economic Disadvantage (IRSD) (Australian Bureau of Statistics (ABS), 2013b) were derived for each participant's postcode of residence at the time of recruitment to the 45 and Up Study, as recorded by Medicare Australia. These variables were dichotomised as: ARIA (Major City/Inner/Outer Regional; Remote/Very Remote) and SEIFA (Most disadvantaged quintiles 1, 2; Least disadvantaged quintiles 3, 4, 5). Other socio-economic variables were also dichotomised: sex (male; female); age (45–59 years; ≥60 years); income (<\$39,999; ≥\$40,000).

Neighborhood built environment and social support variables

The SEEF questionnaire included six neighborhood built environment questions adapted from the Physical Activity Neighborhood Environment Survey (PANES) (Sallis et al., 2010). These questions asked about access to shops/services, public transit and recreation facilities, presence of sidewalks and personal safety from crime (day and night). Responses option were dichotomised as: disagree (strongly disagree and somewhat disagree) and agree (strongly agree and somewhat agree). The two questions related to levels of crime were reverse scored. Cronbach's alpha coefficients and test–retests reliability ICCs were 0.64

and 0.56, respectively, for the two crime questions and 0.81 and 0.84 for the other neighborhood environment questions, respectively.

Social and neighborhood connections were assessed using eight questions. Dichotomised 'yes/no' responses were sought for survey items about whether the respondent visits neighbors or family outside their local area, can give or receive help from friends and neighbors, is likely to see people they know in their local area, can trust most people in their neighborhood; and if the area has a reputation for being safe. Three further questions from the Duke Social Support Scale (Goodger et al., 1999) asked the respondent how many times per week they spend: time with friends or family they do not live with (dichotomised as 0–3, ≥ 4); at meetings of social clubs, religious/other groups (dichotomised as 0, ≥ 1); and how many people outside home, within 1 h of travel they can depend on or feel very close to (dichotomised as 0–3; ≥ 4).

Healthy lifestyle behaviors

Respondents were also asked whether they had been told by their General Practitioner (GP) to be more physically active in past 12 months (yes/no). Dichotomisation of hours per day spent in sedentary behaviors was based on cut points established from current evidence for unhealthy levels of sitting at 8+ hours (Chau et al., 2013) and high levels of television viewing at 2+ hours (Hu et al., 2001). Hours per day spent sleeping were classified as healthy (7–9 h) or at risk (5–7 h or 9+ hours) Cappuccio, D'Elia (Cappuccio et al., 2010).

Analyses

Data analysis was carried out using SPSS version 21.0. Chi-squared tests were used to compare the sociodemographic profile of Aboriginal and non-Aboriginal participants. Odds ratios (ORs) and 95% confidence intervals (CIs) for Aboriginal versus non-Aboriginal participants for physical activity, sedentary behavior and sleep, neighborhood built environment and social support variables were estimated using forced entry binary logistic regression models, adjusting (where appropriate) for age and sex (Model 1). Models were further adjusted for remoteness of residence (Model 2) and education level (Model 3).

Similar models examined the factors associated with meeting the physical activity recommendations, separately in Aboriginal and non-Aboriginal participants. Effect modification of the relationship between each sociodemographic, behavioral, neighborhood built environment and social support factor and achieving the recommended physical activity levels by Aboriginal status was also examined using interaction tests.

Results

Participants without a valid age or date of entry into the study or a valid response to the question on Aboriginal origin ($n = 910$) were excluded from the analysis. Of the 60,404 respondents to the SEEF study a total of 59,489 (314 Aboriginal; 59,175 non-Aboriginal) participants were included in the analyses (98.5%).

Compared to non-Aboriginal participants, Aboriginal adults were more likely to be younger, have lower levels of educational qualifications and income and live in a disadvantaged area. Aboriginal participants were less likely to live in a major city and be married/living with a partner (all $p \leq 0.001$) (Table 1).

Physical activity and healthy lifestyle behaviors

Table 2 presents the proportion of participants meeting the upper threshold of the physical activity recommendations of >300mins/week, which was high in both Aboriginal (63.1%) and non-Aboriginal respondents (65.4%). A greater proportion of respondents met the lower threshold of the physical activity recommendations of

Table 1

Socio-demographic characteristics of Aboriginal and non-Aboriginal participants of the 2010 SEEF study, New South Wales, Australia.

	Aboriginal (N = 314)%	Non-Aboriginal (N = 59,175)%	p value
Sex			
Male	40.4	46.4	0.034
Female	59.6	53.6	
Age			
45–59	63.4	47.1	< 0.001
60+ years	36.6	52.9	
Education			
None/school/intermediate/HSC	52.9	40.3	< 0.001
Trade/apprenticeship/certificate/ diploma/uni	47.1	59.7	
Marital status			
Single/divorced/separated/widowed	31.8	24.0	0.001
Married/living with partner	68.2	76.0	
Income			
<\$20,000–\$39,000	55.7	40.3	< 0.001
\$40,000+	44.3	59.7	
Remoteness (ARIA +)			
Major City	29.2	43.4	< 0.001
Inner/outer regional/remote/ very remote	70.8	56.6	
SEIFA			
Most disadvantaged quintiles 1, 2	57.3	40.1	< 0.001
Least disadvantaged quintiles 3, 4, 5	42.7	59.9	

>150mins/week (data not shown; 76.9% in Aboriginal and 80.4% in non-Aboriginal respondents, respectively $p = 0.144$). The odds of achieving the upper threshold of the physical activity recommendations did not differ according to Aboriginality, after adjustment for age, sex and ARIA/education. Aboriginal and non-Aboriginal participants did not differ significantly in terms of measures of sedentary behavior. Aboriginal participants had higher odds of being told to be more physically active by their GP in the past 12 months than non-Aboriginal participants in each model (age and sex adjusted OR = 1.90, 95% CI 1.50–2.40; Table 2). Compared to non-Aboriginal participants, Aboriginal participants also had a higher odds of unhealthy sleep duration in each model.

Neighborhood built environment and social support variables

Adjusting for age and sex, Aboriginal respondents had a higher odds of disagreeing that there were *local shops within easy walking distance of home*; *public transport within a 10–15 min walk from home*; *footpaths on most of the streets in neighborhood* or that the *neighborhood has free or low cost recreation facilities* AND HIGHER ODDS OF AGREEING or that *the crime rate makes it unsafe to walk at both day and night*; compared to non-Aboriginal respondents (Table 2). Adjustment for ARIA attenuated the association with accessibility to local shops, recreation facilities and footpaths. Aboriginal respondents had higher odds of indicating that they do not *go outside local area to visit family*, cannot *get help from friends when need it*; DO NOT agree *most people in neighborhood can be trusted* or DO NOT AGREE that their *area has a reputation for being a safe place*, compared to non-Aboriginal respondents. In the model adjusted for ARIA, Aboriginal respondents had a higher odds of reporting they cannot *ask neighbor to help care for someone*, compared to non-Aboriginal respondents.

Aboriginal participants had higher odds of *spending no time in the last week at meetings of social clubs or other group meetings* (compared to 1+) or having *0–3 people outside home that they can depend on* (compared to 4+) compared to non-Aboriginal participants. Other neighborhood built environment, neighborhood connections and social support variable responses were similar among Aboriginal and non-Aboriginal participants.

Table 2
Physical activity (PA), healthy lifestyle behaviors, neighborhood characteristics and social support among Aboriginal and non-Aboriginal participants of the 2010 SEEF study, New South Wales, Australia.

	Aboriginal N = 314%	Non-Aboriginal N = 59,175%	Odds Ratios for Aboriginal vs non-Aboriginal participants (reference group)		
			Model 1 adjusted for age, sex	Model 2 adjusted for age, sex and remoteness of residence	Model 3 adjusted for age, sex and education
<i>PA, healthy lifestyle behaviors</i>					
Meets PA recommendations >300 min/week (no)	36.9	34.6	1.15 (0.89–1.47)	1.18 (0.92–1.51)	1.14 (0.89–1.47)
8+ hours per day spent sitting	36.4	36.0	1.06 (0.79–1.40)	1.13 (0.85–1.51)	1.08 (0.81–1.43)
2+ hours per day spent watching TV	57.2	56.3	1.07 (0.80–1.44)	1.04 (0.77–1.40)	0.99 (0.73–1.34)
5–7/9+ hours per day spent sleeping	34.7	20.8	2.10* (1.66–2.68)	2.11* (1.66–2.69)	2.03* (1.60–2.59)
Told by GP to be more active, past 12 months	35.6	22.3	1.90* (1.50–2.40)	1.95* (1.54–2.48)	1.81* (1.43–2.30)
<i>Neighborhood built environment</i>					
Local shops within easy walking distance of home (disagree)	59.0	53.5	1.26* (1.01–1.59)	1.12 (0.89–1.42)	1.28* (1.01–1.61)
Public transport within 10–15 min walk from home (disagree)	38.2	26.7	1.67* (1.32–2.10)	1.33* (1.03–1.71)	1.63* (1.29–2.06)
Footpaths on most streets in neighborhood (disagree)	54.2	43.9	1.51* (1.21–1.89)	1.24 (0.97–1.58)	1.49* (1.19–1.87)
Neighborhood has free/low cost recreation facilities (disagree)	35.4	26.2	1.49* (1.18–1.88)	1.25 (0.98–1.60)	1.40* (1.10–1.78)
Crime rate makes it unsafe to walk: NIGHT (agree)	33.7	26.6	1.53* (1.20–1.95)	1.58* (1.24–2.01)	1.44* (1.13–1.84)
Crime rate makes it unsafe to walk: DAY (agree)	13.0	4.6	3.31* (2.36–4.63)	3.41* (2.43–4.77)	3.09* (2.20–4.33)
<i>Neighborhood connections</i>					
Go outside local area to visit family (no)	20.5	15.0	1.53* (1.16–2.03)	1.59* (1.21–2.11)	1.45* (1.10–1.93)
Can get help from friends when need it (no)	11.1	6.0	1.88* (1.31–2.69)	1.92* (1.34–2.75)	1.77* (1.23–2.56)
Can ask neighbor to help care for someone (no)	49.8	42.8	1.23 (0.98–1.54)	1.26* (1.00–1.58)	1.23 (0.98–1.55)
Visited neighbor in past week (no)	47.7	45.2	1.00 (0.80–1.26)	1.04 (0.83–1.31)	1.02 (0.81–1.23)
Likely to run into friends and acquaintances locally (no)	12.3	13.7	0.85 (0.60–1.19)	0.97 (0.69–1.37)	0.89 (0.63–1.26)
Done favor for sick neighbor in past 6 months (no)	50.6	54.7	0.80 (0.63–1.00)	0.83 (0.66–1.04)	0.82 (0.65–1.02)
Agree most people in neighborhood can be trusted (no)	22.0	12.1	1.89* (1.43–2.49)	1.99* (1.51–2.62)	1.84* (1.39–2.43)
Area has reputation for being a safe place (no)	16.3	8.4	2.02* (1.48–2.74)	2.18* (1.60–2.97)	1.96* (1.44–2.68)
<i>Social support</i>					
0–3 vs 4+ Times last week with friends, family (do not live with)	59.0	59.0	0.96 (0.76–1.21)	0.97 (0.77–1.22)	0.94 (0.75–1.19)
0 vs 1 Times last week at social clubs, other groups meetings	55.4	44.7	1.40* (1.11–1.78)	1.41* (1.11–1.78)	1.36* (1.07–1.72)
0–3 vs 4+ People outside home, within 1 h travel can depend on	44.1	36.5	1.35* (1.08–1.70)	1.35* (1.08–1.70)	1.31* (1.04–1.64)

Model 1: adjusted for age, sex.

Model 2: adjusted for age, sex and ARIA where appropriate.

Model 3: adjusted for age, sex and education where appropriate

* Statistical significance $p < 0.05$.

Correlates of meeting physical activity recommendations among Aboriginal and non-Aboriginal participants

Non-Aboriginal participants had a higher odds of meeting the physical activity recommendations if they were female, younger (<60 years), married/living with a partner, living in a major city, more educated and earning more income ($\geq \$40,000$; Table 3). Although associations were statistically significant among the non-Aboriginal participants only, the OR and 95% CI among the Aboriginal participants were consistent with those for non-Aboriginal participants and tests for statistical interaction according to Aboriginality were not significant. Repeating the models using the lower threshold of the 150 mins/week physical activity recommendations did not materially alter the findings regarding these associations (data not shown).

In both Aboriginal and non-Aboriginal groups, those who were told to be more physically active by their GP in the past 12 months had a lower odds of meeting the physical activity recommendations (OR = 0.35, 95% CI 0.20–0.60 and OR = 0.46, 95% CI 0.44–0.48, respectively; Table 3). Compared to those who sat for more than eight hours a day, only the non-Aboriginal respondents who spent less than eight hours a day sitting had a higher odds of meeting the physical activity recommendations (OR = 1.75, 95% CI 1.67–1.83). Similarly, non-Aboriginal respondents with four or more people outside home that they can depend on also had a higher odds of meeting the physical activity recommendations compared to those with fewer social contacts (OR = 1.37, 95% CI 1.32–1.42).

In the non-Aboriginal group, those who disagreed that: they have easily accessible public transport, local footpaths and crime rate made it unsafe to go out (day or night) had a higher odds of meeting the

physical activity recommendations. Those who answered 'yes' to the seven questions relating to support from family, friends and neighbors and those who perceived their neighborhood as a safe place had a higher odds of meeting the physical activity recommendations. Participants who disagreed that there are local shops within easy walking distance of home had a lower odds of meeting the physical activity recommendations. Those who spent more time (≥ 4 vs 0–3) in the last week with friends, family they do not live with or any time at social clubs, other groups meetings had a higher odds of meeting the physical activity recommendations. Further adjustment for remoteness of residence did not materially alter the findings. After adjusting for education, the odds of meeting physical activity recommendations increased for those who spent less than eight hours a day sitting (OR = 1.86, 95% CI 1.00–3.45) and also for those with four or more people outside home that they can depend on and physical activity (OR = 1.69, 95% CI 1.01–2.83) increased (Supplementary Table).

The relationship of each of the sociodemographic, behavioral, neighborhood built environment and social support factors to meeting the physical activity recommendations did not vary significantly according to Aboriginality ($p[\text{interaction}] \geq 0.1$).

Discussion

A large proportion of Aboriginal and non-Aboriginal participants met the upper threshold of the recommended levels of physical activity. Socio-demographic factors relating to higher levels of PA included female sex, younger age, higher educational qualifications, higher income, being married/partnered and residing in non-major city areas. Factors associated with achieving physical activity guidelines were similar

Table 3

Socio-demographic, behavioral, neighborhood and social support correlates of meeting physical activity recommendations of >300 min/week in the, adjusted for age and sex.

	Aboriginal N = 314		Non-Aboriginal N = 59,175	
	% meet PA	Odds ratios	% meet PA	Odds ratios
<i>Socio-demographic</i>				
<i>Sex</i>				
Male	62.6	1.00	64.1	1.00
Female	63.4	1.03 (0.62–1.71)	66.4	1.08* (1.04–1.12)
<i>Age</i>				
45–59	66.5	1.00	67.4	1.00
60+ years	55.8	0.64 (0.38–1.08)	54.4	0.84* (0.81–0.87)
<i>Education</i>				
None/school/intermediate/HSC	60.6	1.00	62.5	1.00
Trade/apprenticeship/certificate/diploma/uni	64.6	1.11 (0.67–1.86)	67.4	1.24* (1.19–1.29)
<i>Marital status</i>				
Single/divorced/separated/widowed	60.8	1.00	60.8	1.00
Married/living with partner	66.7	1.05 (0.60–1.84)	66.7	1.29* (1.24–1.35)
<i>Income</i>				
<\$20,000–\$39,000	55.7	1.00	63.0	1.00
\$40,000+	68.6	1.55 (0.88–2.76)	67.8	1.22* (1.12–1.27)
<i>Remoteness (ARIA+)</i>				
Major city	59.0	1.00	63.8	1.00
Inner/outer regional/remote/very remote	64.6	1.24 (0.72–2.15)	66.6	1.13* (1.09–1.17)
<i>SEIFA</i>				
Most disadvantaged quintiles 1, 2	63.3	1.00	65.2	1.00
Least disadvantaged quintiles 3, 4, 5	62.7	0.99 (0.60–1.64)	65.4	1.01 (0.97–1.05)
<i>Healthy lifestyle behaviors</i>				
<i>Hours per day spent sitting</i>				
Unhealthy 8+ hours	50.0	1.00	55.8	1.00
Healthy <8 h	64.8	1.81 (0.98–3.35)	68.1	1.75* (1.67–1.83)
<i>Hours per day spent watching TV</i>				
High 2+ hours	63.6	1.00	64.9	1.00
Low ≤2 h	60.0	0.84 (0.43–1.62)	67.9	1.11* (1.06–1.17)
<i>Hours per day spent sleeping</i>				
Unhealthy 5–7/9+ hours	62.9	1.00	60.8	1.00
Healthy 7–9 h	64.5	1.05 (0.61–1.79)	67.1	1.30* (1.25–1.36)
<i>Told by GP to be more active, past 12 months</i>				
No	71.8	1.00	69.7	1.00
Yes	46.7	0.35* (0.20–0.59)	51.3	0.46* (0.44–0.48)
<i>Neighborhood built environment</i>				
<i>Local shops within easy walking distance of home</i>				
Agree	66.0	1.00	66.9	1.00
Disagree	61.8	0.83 (0.49–1.39)	64.4	0.90* (0.87–0.93)
<i>Public transport within 10–15 min walk from home</i>				
Agree	64.8	1.00	64.9	1.00
Disagree	61.4	0.84 (0.50–1.43)	67.2	1.11* (1.06–1.15)
<i>Footpaths on most of streets in neighborhood</i>				
Agree	64.4	1.00	64.0	1.00
Disagree	62.8	0.91 (0.55–1.51)	67.4	1.15* (1.11–1.20)
<i>Neighborhood has free or low cost recreation facilities</i>				
Agree	64.1	1.00	65.7	1.00
Disagree	62.5	0.93 (0.55–1.57)	65.0	0.96 (0.92–1.00)
<i>Crime rate makes it unsafe to walk: NIGHT</i>				
Agree	55.3	1.00	60.0	1.00
Disagree	67.0	1.60 (0.93–2.75)	67.4	1.37* (1.32–1.43)
<i>Crime rate makes it unsafe to walk: DAY</i>				
Agree	57.6	1.00	54.7	1.00
Disagree	63.5	1.18 (0.56–2.50)	66.0	1.59* (1.46–1.73)
<i>Neighborhood connections</i>				
<i>Go outside local area to visit family</i>				
No	62.7	1.00	57.7	1.00
Yes	63.9	1.09 (0.60–2.01)	66.7	1.46* (1.38–1.53)
<i>Can get help from friends when need it</i>				
No	59.3	1.00	55.6	1.00
Yes	64.7	1.26 (0.56–2.85)	66.1	1.58* (1.46–1.70)
<i>Could ask neighbor to help care for someone</i>				
No	59.8	1.00	63.2	1.00
Yes	68.3	1.57 (0.93–2.66)	67.5	1.25* (1.20–1.29)
<i>Visited neighbor in past week</i>				
No	59.0	1.00	61.8	1.00
Yes	68.2	1.53 (0.92–2.54)	68.6	1.39* (1.34–1.45)
<i>Likely to run into friends and acquaintances locally</i>				
No	63.9	1.00	58.4	1.00
Yes	63.4	0.96 (0.46–2.01)	66.6	1.44* (1.37–1.52)

(continued on next page)

Table 3 (continued)

	Aboriginal N = 314		Non-Aboriginal N = 59,175	
	% meet PA	Odds ratios	% meet PA	Odds ratios
Done favor for sick neighbor in past 6 months				
No	60.4	1.00	62.8	1.00
Yes	66.9	1.47 (0.87–2.48)	68.8	1.33* (1.28–1.38)
Agree most people in neighborhood can be trusted				
No	56.1	1.00	60.9	1.00
Yes	65.2	1.49 (0.82–2.74)	66.2	1.29* (1.22–1.37)
Area has reputation as a safe place				
No	60.0	1.00	60.4	1.00
Yes	65.1	1.20 (0.60–2.42)	66.0	1.30* (1.22–1.38)
<i>Social support</i>				
Times last week with friends, family (do not live with)				
0–3	63.2	1.00	62.0	1.00
4+	64.9	1.05 (0.63–1.76)	70.8	1.51* (1.46–1.57)
Times last week at social clubs, other groups meetings				
0	59.3	1.00	62.4	1.00
1+	68.4	1.61 (0.95–2.73)	68.1	1.33* (1.28–1.38)
People outside home, within 1 h travel can depend on				
0–3	57.9	1.00	61.0	1.00
4+	68.2	1.62 (0.97–2.71)	68.1	1.37* (1.32–1.42)

Test of interaction by Aboriginality of sociodemographic, behavioral, neighborhood built environment and social support variables and meeting the physical activity recommendations were not statistically significant.

* Statistical significance $p < 0.05$.

between Aboriginal and non-Aboriginal participants. Neighborhood conditions such as low crime rate and greater social interaction/social support were associated with achieving the physical activity recommendations. Despite less favorable neighborhood environments, the proportion of Aboriginal participants achieving the recommended physical activity recommendations was similar to the proportion of non-Aboriginal participants.

Given these high proportions and the tendency for physical activity to be over reported when measured through self report (Brown et al., 2004b), we focused on the results of the modeling of the upper threshold of the recommendations. While these high levels of physical activity are encouraging, particularly among the Aboriginal participants, they may in part be due to a 'healthy cohort effect' where participants in studies tend to be healthier than the overall population from which they are sampled (Struijk et al., 2015).

The socio-demographic, neighborhood built environment and social support correlates of physical activity are largely consistent with existing literature (Saelens et al., 2003; Foster et al., 2014) in both Aboriginal and non-Aboriginal participants in our sample. An exception to this was our finding that females were more active than males. Males are typically more active than females in Australia (Australian Bureau of Statistics (ABS), 2013a) and internationally (Guthold et al., 2008). However, in specific population sub groups, including ethnic minorities and middle to older aged adults, females tend to be more active than males or rates are similar (Hawkins et al., 2009; Martin et al., 2014). Our findings appear to reflect these differences according to gender and across the life-course, both in the Aboriginal and non-Aboriginal sub groups.

Factors that influence physical activity can be explained through the socio-ecological model which takes account of both individual and social environmental aspects (McLeroy et al., 1988). The model has been adapted to include specific factors influencing physical activity participation among Aboriginal Australians, such as colonisation (structural macro-social factor), feeling unsafe in a physical environment (structural environmental factor) and family and community connections (social connections) (Nelson et al., 2010). While our findings highlight that Aboriginal people experience less desirable neighborhood environments, as well as lower indicators of social support, similar levels of physical activity are achieved. This may be due to a cultural emphasis on, or acceptability of, physical activity and sport among Aboriginal people (Thorpe et al., 2014). Other influencing factors could include a level

of resilience among the Aboriginal sample in our study where despite less than ideal conditions for health, reasonable health outcomes can be achieved. Evidence of links between resilience and Aboriginal health are emerging but appears to be positively associated with a strong traditional culture (Currie et al., 2013); therefore emphasising cultural connections is important. Other determinants of physical activity in Aboriginal populations may not yet be known or understood. Further, analyses of cohort studies including Aboriginal people, or qualitative exploratory research may elucidate greater insights.

Aboriginal participants were more likely to have unfavorable neighborhoods compared to non-Aboriginal participants. However, following adjustment for remoteness of residence, some of these associations were attenuated which could be attributed to Aboriginal Australians being more likely to live in rural/remote areas than non-Aboriginal Australians (Australian Bureau of Statistics (ABS), 2011). The use of the adapted PANES, which was established to measure physical activity and neighborhood environment aspects in urban populations only (Sallis et al., 2010), may also in part explain these findings. The development and validation of a corresponding measure for non-urban neighborhoods is important for future investigation. Further, some of the findings where the direction of association differed between participant groups, such as distance from public transport and presence of footpaths, could be due to the use of the PANES in a cohort where ARIA differed according to Aboriginality. Regardless, these findings indicate that for the majority of neighborhood built environment attributes, Aboriginal participants were more likely to experience or perceive a less satisfactory position, even after accounting for education, a commonly used indicator of (dis)advantage.

Hence, these data show that features of the neighborhood environment are associated with physical activity levels and that Aboriginal people report less physical activity favorable neighborhood attributes. The findings suggest that addressing features of the neighborhood and environment, such as walkability, crime and amenities could specifically improve physical activity levels. They also provide general support for policy based on the social determinants of health, where financial resources and the everyday conditions in which people live and work, such as the neighborhood environment, are targeted to reduce inequalities that influence health (Friel and Marmot, 2011). Recent evidence highlights the role of neighborhood walkability and safety in mediating the association between education level and physical activity (Pratt et al., 2015) suggesting specific modifiable neighborhood features.

This study found that those participants who were told to be more active by their GPs were those who were less likely to be achieving the physical activity recommendations suggesting that both Aboriginal and non-Aboriginal people are receiving the appropriate health advice. The effectiveness of GP advice to patients to be more physically active is well established (Orrow et al., 2012), but widespread implementation of such advice remains a public health challenge. A recent national survey demonstrated less than a fifth of participants had received advice from their GP to be active in the past year, but similar to our study, advice was more commonly given to those with poorer health (Short et al., 2015). Further exploration of GP advice to be physical active longitudinally would help understand how this strategy can be best utilised and establish whether the provision of such advice leads to behavior change over time. Specific training, protocols and resource provision for GPs may prove effective measures.

Among non-Aboriginal people, those who spent less than eight hours a day sitting were significantly more likely to meet the physical activity recommendations. A similar, but non-significant, finding was also evident in Aboriginal people. This is consistent with the evidence for the health risks of lengthy time periods spent sitting that has been established in recent years in mainstream populations (Bennie et al., 2013) and across sex and race groups in the U.S. (Staiano et al., 2014). Little is known of sitting time prevalence and associated health risks among Australian Aboriginal people although recent ABS data found Aboriginal adults in non-remote areas spent an average of 5.3 h per day in sedentary behavior, which was less than their non-Aboriginal counterparts (Australian Bureau of Statistics (ABS), 2014b). These findings provide emerging evidence of the association between physical activity and sitting time which should be examined in future epidemiological studies of health behaviors in Aboriginal populations.

This study showed that social support was correlated with achieving the physical activity recommendations. Having four or more people outside home to depend on was significantly associated with meeting the physical activity recommendations. Social support is an established correlate of physical activity in the general population (Nieminen et al., 2013) and given the holistic context of Aboriginal health, where physical, mental, social and spiritual aspects are interconnected, it could possibly have a stronger influence. However, given that we also found Aboriginal people were less likely to have four or more people outside home to depend on, as well as being less likely to spend time in the past week at social clubs; this seems to reflect an overall lower level of social connect within this Aboriginal sample. Yet it should be noted that the Duke Social Support Scale used in this study focuses on social contacts outside the home, which may not capture social support within the household or family; such household and family support may be of greater importance to Aboriginal people (Williamson et al., 2010).

Strengths of the present study include the large sample of almost 60,000 middle-older age adults and a relatively large sample of Aboriginal participants followed up in a cohort study. The SEEF study captures data on many indicators of the neighborhood built environment and social support together in a study of this magnitude. It provides data for the first time of these behavioral, social and environmental characteristics together within a specific Australian Aboriginal population group and one of the first of any Indigenous populations internationally. The findings should be acknowledged within several limitations including the self-reported, cross-sectional nature of the study and the small number of Aboriginal, relative to non-Aboriginal, respondents. This led to a larger number of significant associations in the non-Aboriginal population. However, testing of interaction effects revealed no differences between the two groups. Therefore, the non-significant findings in Aboriginal people where the direction of associations and magnitude of ORs matched that of the non-Aboriginal participants can be attributed in part to the smaller Aboriginal sample size. However, with several hundred Aboriginal participants, this study is large relative to many other Aboriginal studies. Further, there may have been sample bias reflecting participants with higher levels of literacy and education

level than the general population, particularly among Aboriginal people who experience higher levels of disadvantage. In light of these strengths and limitations, it is important not to over-interpret non-significant findings in this context, and to not infer causality from the observed associations.

Conclusions

Despite unfavorable neighborhoods and reduced social support, Aboriginal participants in this cohort were as likely to be achieving the physical activity recommendations compared to non-Aboriginal participants. Factors associated with achieving the recommendations were similar between Aboriginal and non-Aboriginal participants and included younger age, higher education, higher income, greater social support and more favorable neighborhood conditions such as perceived low crime rates. Given that significant disparities in the neighborhood built environment and social support were found among Aboriginal compared to non-Aboriginal people; this is an important area for future research and public health policy and programs.

Supplementary data to this article can be found online at <http://dx.doi.org/10.1016/j.pmedr.2016.01.006>.

Conflict of interest

The authors declare that there are no conflicts of interests.

Transparency document

The Transparency document associated with this article can be found, in online version.

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