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RESEARCH ARTICLE

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Physical activity and sedentary behaviour among south Asian immigrants in Australia

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Abstract

Issue Addressed: South Asians make up the second-largest group of immigrants in Australia and experience a higher burden of chronic diseases compared with non-immigrants. Most chronic diseases are associated with insufficient physical activity (PA) and sedentary behaviour (SB); however, studies involving PA and SB in immigrants are limited. This study aimed to explore PA and SB and associated factors among South Asian immigrants in Australia.

Methods: South Asian adult immigrants in Australia were surveyed online (from November 2020 to March 2021) about PA, SB, knowledge and barriers to PA. Logistic regressions were used to examine factors associated with insufficient PA (<150 minutes/week) and a high sitting time (>8 hours/day).

Results: A total of 321 participants provided complete data. Approximately 76% of participants reported insufficient PA and 27% reported high sitting time. Only 6% of participants walked or bicycled. The main reported barriers to PA were lack of time, costs, transport facilities, skills, and culturally appropriate resources. Around 52% of participants were not aware of the importance of PA. Participants with self-reported poor health and who used motorized travel were more likely to have inadequate PA. High sitting time was more common among middle-aged, overweight/obese, and middle-income participants.

Conclusions: Most South Asian immigrants are insufficiently active with a lack of socio-economically appropriate PA facilities identified as a major challenge. A stronger collaboration between policymakers and community is required for sustainable solutions.

So What?: Affordable and appropriate PA facilities in neighbourhoods could overcome major barriers. Also, information about PA should incorporate cultural expectations in the general recommendations to encourage participation.

KEYWORDS
activity behaviours, barriers, exercise, knowledge, lifestyle, migrants

1 | INTRODUCTION

The largest number of immigrants (280 million) in high-income countries are from the densely populated countries of South Asia, including Afghanistan, Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka.[1] Compared with non-immigrants, South Asian immigrants are at higher risk of developing chronic diseases,[2] particularly heart disease, diabetes, stroke, and hypertension.[1] For example, the prevalence of type 2 diabetes is three to five times higher in South Asian immigrants compared with non-immigrant groups in the United Kingdom, Canada, and the United States.[3] Increased risk of chronic disease among South Asian immigrants can be attributed to a variety of factors: genetic predisposition, poor diet, insufficient physical activity (PA), and a sedentary lifestyle. Compared with non-immigrants in host countries, these factors increase the risk of South Asian immigrants developing cardiovascular diseases, diabetes and stroke at younger ages.[4,5]

Sufficient PA, defined as 150–300 minutes of moderate activity or 75–150 minutes of vigorous activity per week,[6] protects against many chronic diseases, including hypertension, heart disease, and diabetes,[5,7,8] whereas prolonged sedentary time, defined as sitting more than 8 hours a day, is associated with a higher risk of developing diabetes, hypertension, and obesity.[9,10] Despite the benefits of PA, studies have shown South Asian immigrants to be less physically active than non-immigrants in high-income countries.[7,11–13] An integrative review of PA studies involving South Asian Indian immigrants reported low PA levels in at least 40% of Indian immigrants in the United States, Europe, Australia, and New Zealand.[13] Similarly, data from a Canadian Community Health Survey revealed that only 34% of South Asian immigrants met Canadian PA guidelines.[14]

PA behaviours of South Asian immigrants are mostly influenced by cultural norms and perceptions, socio-economic conditions, and acculturation levels in high-income host countries.[15] In Western countries, spaces, where South Asian immigrants can engage in PA, are restricted by gender interactions and clothing defined by cultural and religious expectations.[15–18] Leisure time PA is also severely hindered by work demands and cultural expectations of spending time with family rather than participating in leisure time PA.[18,19] South Asian women also report less opportunities to participate in PA activities due to gender and cultural expectations to remain at home.[20,21] Studies also report that cultural norms strongly influence interpretations of different PAs among South Asian immigrants.[15–18] For example, housework and taking care of children are considered major PA for South Asian immigrants.[18] Other barriers preventing immigrant participation in PA have been identified as a lack of conveniently located spaces, social support, self-efficacy, access to affordable PA options, and a perception of not having enough time to take part in PA.[18,19]

Another barrier preventing South Asian immigrants from participating in PA in high-income countries may be a lack of intention.[21,22] This could be due to work responsibilities limiting free time, social isolation in a new country,[15] or South Asian families prioritising education over exercise, influencing PA behaviours in successive generations.[23] Also, most South Asian immigrants migrate to developed countries because of economic hardships; therefore, the general resources of most South Asian's are limited negatively impacting participation in PA.[22] In accordance with a cultural belief that motorized transport symbolizes prosperity, many South Asians also intentionally avoid walking or cycling for transportation.[21] Limited knowledge about the positive health benefits of PA,[24] attributed to low educational levels or language barriers, maybe another factor limiting immigrant participation in PA.[10,13,24] Understanding the correlates of habitual levels of PA participation by South Asian immigrants could help develop strategies to promote more active behaviours and prevent chronic disease.[25]

The highest number of Australian immigrants are from South Asian countries.[26] Compared to other high-income countries, research into the PA behaviours of South Asian immigrants in Australia is not only lacking[27] but also inconsistent. For example, in a study involving Afghani, Sri Lankan, and Bhutanese immigrants living in Australia for more than 12 months, immigrants were five times more likely to be insufficiently active than the Australian-born population.[28] Conversely, data from the 45 and up study reported a lower prevalence of insufficient PA among South Asian immigrants (4.8%) than Australian-born people (5.2%).[29] Even though some studies have reported the prevalence of PA among South Asian immigrants in Australia, no studies have measured sedentary behaviour (SB) or explored correlates of SB,[30] and only a few studies have examined the potential barriers to PA participation among South Asian immigrants in Australia.[20,21,31,32] However, investigations into the correlates of PA and the level of knowledge about PA among South Asians in Australia are lacking. A better understanding of PA and SB among South Asian immigrants in Australia could help develop appropriate strategies to increase habitual levels of PA in this rapidly growing immigrant population. Therefore, this study was designed to explore PA and SB profiles of South Asian immigrants in Australia and determine the prevalence and correlation of PA and SB.

2 | METHODS

2.1 | Study population and design

An online survey was conducted between 1 November 2020, and 30 March 2021 using Checkbox. 'Checkbox' is a web-based e-Survey software package that offers innovative attributes and design options to support researchers in their empirical investigations.[33] Participants were recruited through social media (eg, Facebook and Twitter), Prolific Academic (ie, an online crowdsourcing platform created by academics for the purpose of recruiting research participants),[34] and email lists provided by community organizations. Snowball sampling was also used by asking participants to invite their friends and families to participate. Potential participants were also approached at cultural centres, community gatherings, and organizations (eg, multicultural Australian and Urdu forums).

The study included adult immigrants (aged 18 or older) born in South Asian countries and who had lived in Australia for more than 2 years. Due to differences in their representation within the health care system (legal and financial barriers to accessing health care),[35,36] asylum seekers, and refugees were not included in the study.

2.2 | Ethical consideration

This study was performed in accordance with the principles of the 1964 Declaration of Helsinki and its later amendments. The study received ethical approval from the Human Ethics Research Committee of the University of Queensland, Australia (Reference number: 2019001535).

2.3 | Measures

2.3.1 | Physical activity

PA was measured using the Active Australian Survey. During the past 10 years, the Active Australia survey has been widely used to measure PA in Australian national and state surveys.[37] The measurement properties of this survey have been assessed and are known to be as good or better than other commonly used PA surveys.[37] Participants responded to questions about the time spent in various activities for the previous 7 days. These activities included: (i) walking for recreation, exercise, or to get to or from places (walktime); (ii) doing vigorous gardening or heavy work around the yard (vigtime); (iii) vigorous-intensity PA (eg, jogging) (vigsess); and (iv) moderate-intensity PA (eg, slow swimming) (modtime).[38] Participants were asked to only report activities that lasted 10 minutes or more. As shown below, total time of PA (ie, sufftime = sufficiently active time) was calculated by adding the time spent in walking and moderate activity to twice the time spent in vigorous activity (not including gardening and yard work) in minutes. The time spent in vigorous activity was doubled because vigorous activity is more intense producing greater health benefits than moderate activity

[sufftime = walktime + modtime + (2 × vigtime)].[38]

Participants undertaking at least 150 minutes of PA per week were classified as 'sufficiently active', while those doing less were classed as 'insufficiently active'.[5,8] The usual mode of transport was measured by asking 'On most weekdays (Monday to Friday), which type of transport do you mainly use to get to and from places?'. Responses included public transport, car or motorcycle, walking and bicycle. Answers were dichotomised into active (walking and bicycle) and motorised transport (public transport and car or motorcycle).[39] Change in the PA levels after moving to Australia is asked by the question, 'Compared to your own level of physical activity, what would you say after migration your PA levels are:'. The responses are recorded as 'more, less, about at the same levels and not sure'.

2.3.2 | Sedentary behaviours

SB items were adapted from the Australian Longitudinal Study on Women's Health.[40] The measurement properties of SBs used in the Australian Longitudinal Study on Women's Health have been evaluated and are equivalent to those of other commonly used surveys on sitting time in Australian and US studies.[40,41] Participants responded to questions about time spent sitting (hours, minutes) on a usual weekday and weekend day across four domains: (i) whilst travelling, (ii) watching television (including gaming), (iii) in general leisure, and (iv) using a computer at home.[42] These measures have acceptable levels of reliability and validity for assessing adult SB.[42] Daily sedentary time was derived from weekday and weekend sedentary data.[39] Data were converted to minutes/day for each context.[43] Total daily sitting time on an average weekend day and weekday was categorized as high (>8 hours/day) or low (≤8 hours/day).[9,10,43]

2.3.3 | Awareness of PA

Knowledge about PA was assessed using five statements from the Active Australian survey.[38]

These five statements are presented in Figure 2. The Likert scale was used to record responses that were categorised into agree (strongly agree, agree) and disagree (disagree, strongly disagree).

2.3.4 | Barriers to PA

Participants were asked about their perceived barriers to participating in PA through the following question: 'What are the factors which usually prevent you to participate in physical activity?'. A list of potential responses included 23 items with yes or no options (Figure 3). Participants could select as many items that were applicable to them. Possible barriers were based on those used by previous studies.[39,44,45] Barriers were divided into two groups: internal barriers and external barriers.[46] External barriers referred to factors beyond an individual's control, whereas internal barriers are applied to factors perceived by an individual.[25] An understanding of internal and external barriers is needed to design better and more focused intervention and policy programmes.[25,47] Intention to participate in PA was assessed using the five-point Likert scale by asking 'How strong or weak is your intention to be physically active?'.[39] Responses were categorised into weak (very weak, weak, and not sure) and strong (strong, very strong). The 'weak' intention was added to the internal barrier list.[46]

2.3.5 | Socio-demographic and health covariates

Socio-demographic factors included: age; gender; marital status; highest educational level attained; monthly gross household income; employment status; country of birth; language spoken at home; duration of stay; and mode of usual transport.[13,48] Self-reported health was assessed by asking the question,[39] 'In general, how would you rate your current overall physical health?'. The five-point scale was used to record responses that were categorised into poor (very poor and poor) and good (good, very good and excellent). Body mass index (BMI) was calculated from self-reported height and weight.[49]

TABLE 1 Characteristics of the analytical sample ($n = 321$).

Characteristics	N	%
Sex		
Male	177	55.8%
Female	143	44.2%
Age (years)		
18-30	40	12.6
31-40	142	44.7
41-50	84	26.4
> 50	52	16.4
Country of birth[a]		
Pakistan	103	32.6
India	93	29.4
Other South Asian countries[a]	120	38.0
Employment status		
Full-time work	167	52.5
Part-time/casual work	80	25.2
Unemployed	71	22.3
Highest educational qualification		
Certificate	32	10.1
Bachelor/diploma	129	40.7
Postgraduate degree	156	49.2
Gross annual household income (AUD)		
Low-income group (≥ $0 36 399)	59	22.7
Middle-income group ($36 400-93 599)	112	43.1
High-income group ($93 600+)	89	34.2
Years since immigration		
0-5 years	129	40.3
5-10 years	98	30.6
More than 10 years	93	29.1
Home language		
English	68	21.5
Other than English	249	78.5
Self-reported health status		
Poor	44	16.7
Good	220	83.3
Transport		
Active (cycling, walking)	21	6.5
Motorised (car, bus, etc.)	300	93.5
Prevalence of physical activity and sitting time		
Insufficiently active	244	76
High sitting time (>8 h/d)	73	27
PA[b] after migration		
Increase in PA levels	177	71.9
Decrease in PA levels	35	28.1
BMI (kg/m^2)		
Normal	114	36.5
Overweight/obese	198	63.5

[a]Afghanistan, Bangladesh, Bhutan, Maldives, Nepal, and Sri Lanka.
[b]PA = physical activity.

2.3.6 | Statistical analysis

Analyses comprised descriptive statistics and proportions including 95% confidence intervals (CIs). Significance was assumed at $P < .05$. Proportions of variables of interest were calculated. Two dichotomous outcome variables considered for examining their correlates were[1]: sufficient (≥150 minutes of PA) versus insufficient PA and[2] low (≤8 hours/day) versus high sitting time. Binary logistic regression was used to examine associations of sample characteristics (ie, age, gender, education, income, employment status, country of birth, language spoken at home, physical health, duration of stay, and mode of usual transport) with the outcome variables. Sample characteristics that had univariate associations with insufficient PA and high sitting time were identified and examined for collinearity. Two separate multivariable logistic regression models were then constructed to examine adjusted correlates of [a] insufficient PA and [b] high sitting time. The model fit was verified by using the Hosmer-Lemeshow test. Adjusted estimates of the associations are presented as odds ratios and their 95% CI. All descriptive and regression analyses were performed using SPSS V26.[50]

3 | RESULTS

3.1 | Participants

Of the 460 participants who attempted the online survey, 321 responded with complete PA and SB data that were included in the analyses. Study participant characteristics are presented in Table 1 and are summarised as follows: mean age was 35 years (SD 7.06); majority (56%) were males; almost half (49%) had tertiary education; more than half (63%) were obese/overweight; and most (83%) reported good physical health.

3.2 | PA and SBs

Over three-quarters, (76%) of participants were insufficiently physically active and more than one-quarter (27%) were sedentary for more than 8 hours/day (Table 1). Only 14% of participants were sufficiently active and seated less than 8 hours/day (Figure 1). Overall, only 6% of

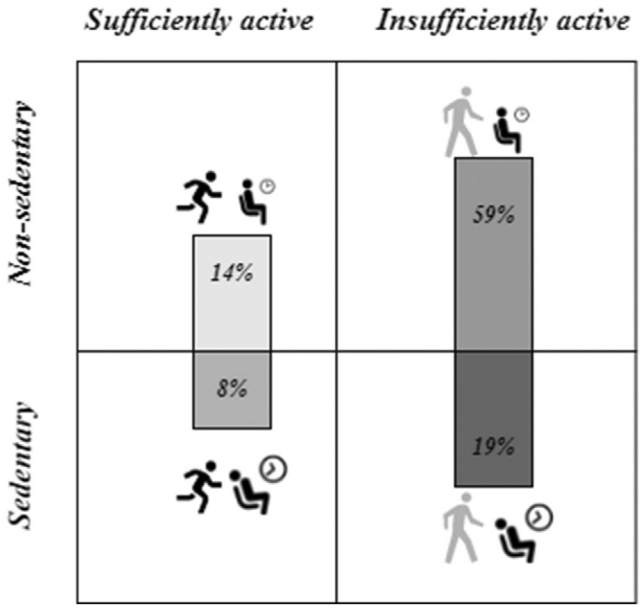

FIGURE 1 Prevalence of active lifestyle behaviours (sedentary, sufficiently active, and insufficiently active) among South Asian immigrants. Sedentary behaviours are defined as sitting time >8 hours/day.[9] Sufficient activity is defined as 150 minutes using the sum of walking, moderate activity, and vigorous activity (weighted by two) and five sessions of activity per week (Active Australian Survey).[38]

participants reported cycling or walking as their main form of transportation on most weekdays. Most of the participants (72%) reported that their PA levels increased after migration (Table 1).

3.3 | Correlates of insufficient PA

Country of birth, physical health, and mode of usual transport was considered in the initial multivariable model based on univariant association (Table 2). When considered in multivariable modelling, none of these variables attained significant association with insufficient PA. Significant univariate associations were found between insufficient PA and immigrants who identified in the middle-income group, self-reported poor physical health, and largely used motorised transport in their travel behaviours (Table 2).

3.4 | Correlates of high sitting time

For high sitting time correlates, age, gender, income, employment status, country of birth, BMI, language spoken at home, and mode of usual transport were initially considered. Employment was excluded because of multicollinearity. Age, income and BMI were significantly associated with high sitting time in univariate analyses and were included in the final multivariable model. None of the other variables was significantly associated with high SBs.

Table 3 presents factors that were associated with high sitting time in the adjusted model. High sitting time (>8 hours/day) was more common among middle-aged participants than younger groups. The likelihood of high sitting time (8 hours/day) was two times higher in participants from the middle-income group compared to the low-income group and in overweight and obese participants compared to participants within a normal weight range.

3.5 | Awareness about PA

The descriptive of five statements from the active Australian survey to access awareness about PA is presented in Figure 2. Participants largely (64%) agreed that 30 minutes of brisk walking is important for health, although over half of participants were not aware of the importance of PA (52%) or did not believe (59%) that 'taking the stairs' was beneficial for their health.

3.6 | Barriers to participating in PA

The main reported internal and external barriers are presented in Figure 3. Lack of time (55%) was the most frequently reported external barrier followed by costs (29%) and problems with transport to reach facilities (20%). Barriers related to cultural norms were reported as a lack of sex-specific facilities (8%), a lack of community gatherings (4%), and negative community perceptions about physical activities (4%). The most frequently reported internal barriers were lack of proper skills and training in performing physical activities (16%), weak intention (13%), and old age (13%).

4 | DISCUSSION

This study aimed to examine the magnitude and correlates of insufficient PA and SB among South Asian immigrants living in Australia. Findings revealed that over three-quarters (76%) of South Asian immigrants in Australia were not sufficiently active and over one-quarter (27%) reported being sedentary for more than 8 hours/day. The main reported barriers to PA were lack of time, lack of same-sex gyms, problems with transport, lack of skills, and weak intention to participate in PA.

Results from this study showed that a higher percentage of South Asian immigrants in Australia do not engage in sufficient levels of PA (76%) compared to the general population (50%).[51] The percentage of South Asian immigrants in Australia who do not participate in sufficient PA is also higher than the prevalence of insufficient PA in different South Asian countries.[17] According to the global observatory 2020, the prevalence of insufficient PA is 28% in Bangladesh, 23% in Bhutan, 34% in India, 7% in Nepal, 34% in Pakistan, and 29% in Sri Lanka.[17] The increased prevalence of insufficient PA among South Asian immigrants compared to their counterparts from their homelands and non-immigrants in Australia may be attributed to different

TABLE 2 Factors associated with insufficient physical activity.

	Total number	In-sufficiently active (%)	Crude OR (95% CI)	*P*-value	Adjusted OR (95% CI)
Sex					
Male	177	72.9	1.00		
Female	140	79.3	0.70 (.41-.18)	.18	NA[a]
Age (years)					
18-30	40	72.5	1.00		
31-40	142	80.3	1.13(.44-2.90)	.78	
41-50	84	70.2	0.73(.34-1.56)	.42	NA[a]
> 50	52	75.0	1.27(.58-2.78)	.54	
Country of birth					
India	93	77.4	1.00		
Pakistan	103	83.5	.65(.35-1.21)	.18	
Other South Asian countries	120	69.2	.44(.23-.84)	.01	NS[b]
Employment status					
Full-time work	167	74.9	1.00		
Part-time/casual work	80	72.5	1.49(.74-3.00)	.25	NA[a]
Unemployed	71	81.7	1.69(.77-3.67)	.18	
Highest educational qualification					
Certificate	32	68.8	1.00		
Bachelor/diploma	129	76.0	1.57(.68-3.62)	.29	NA[a]
Postgraduate degree	156	77.6	1.09(.63-1.89)	.75	
Gross annual household income (AUD)					
≥ $0-36,399	59	33.9	1.00		
$36,400-93,599	112	21.4	1.47(.71-3.01)	.29	NA[a]
$93,600+	89	25.8	.78(.40-1.50)	.46	
BMI (kg/m^2)					
Normal	114	78.1	1.00		
Overweight/obese	198	75.8	0.87(.50-1.52)	.64	NA[a]
Years since immigration					
0-5 years	129	76.7	1.00		
5-10	98	76.5	0.87(.46-1.61)	.66	
More than 10 years	93	74.2	0.88(.45-1.70)	.70	NA[a]
Home language					
English	68	73.5	1.00		
Other than English	249	76.3	0.86(.46-1.59)	.63	NA[a]
Self-reported health status					
Poor	44	93.2	1.00		
Good	220	77.3	0.24(.07-.83)	.02[b]	NS[b]
Mode of transport					
Active (cycling, walking)	21	57.1	1.00		
Motorised (car, bus, etc.)	300	77.3	0.39(.15-.96)	.04[b]	NS[b]

[a]Not applicable for regression analysis.
[b]Not significant in the final multivariable model.

sociocultural factors, lack of appropriate knowledge and skills, and use of different PA scales or data collection techniques.[13,52,53]

The most common external barrier to PA reported by participants was lack of time. These findings are similar to other studies involving South Asians in Australia and the UK[13,52,53] where lack of time due to work demands, family responsibilities, and lack of extended family support were identified as the main factors contributing to insufficient PA.[13,15] In other studies, the primary caregiving roles and domestic

TABLE 3 Factors associated with sedentary behaviours.

	Total number	Sitting time >8 h (%)	Crude OR (95% CI)	*P*-value	Adjusted OR (95% CI)[a]	*P*-value
Sex						
Male	145	33.8	1.00			
Female	119	20.2	2.02(1.14-3.55)	.01	NS[b]	
Age (years)						
18-30	31	12.9	1.00		1.00	
31-40	122	28.7	.26 (.07-.90)	.03	.03 (.00-.35)	<.001
41-50	69	27.5	.72 (.34-1.52)	.39	.50 (.19-1.31)	.16
> 50	42	35.7	.68 (.30-1.55)	.36	.35 (.12-1.00)	.05
Country of birth						
India	82	32.9			NS[b]	
Pakistan	87	19.5	1.14(.60-2.15)	.68		
Other South Asian countries	93	30.1	.56(.28-1.12)	.10		
Employment status Full-time work	103	29.0			E[c]	
Part-time/casual work	45	30.8	1.79(.82-3.89)	.13		
Unemployed	44	18.5	1.95(.82-4.64)	.12		
Highest educational qualification Certificate	17	26.1			NA[d]	
Bachelor/diploma	82	26.1	.85(.31-2.33)	.75		
Postgraduate degree	92	29.2	.85(.48-1.51)	.59		
Gross annual household income (AUD) ≥ $0-36 399	52	48.1				
$36 400-93 599	95	20.0	1.97(.94-4.11)	.07	2.61(1.16-5.86)	.02
$93 600+	72	31.9	.53(.26-1.07)	.08	0.42 (.19-.92)	.03
BMI (kg/m^2) Normal	102	20.6				
Overweight/obese	159	32.1	.54(.30-.98)	.04	2.03(1.01-4.09)	.04
Years since immigration 0-5 years	115	24.3			NA[d]	
5-10	98	30.4	.78(.40-1.51)	.46		
More than 10 years	93	29.2	1.06(.52-2.13)	.87		
Home language English	59	39.0			NS[b]	
Other than English	206	24.3	.50(.27-.92)	.02		
Self-reported health status Poor	36	22.2			NA[d]	
Good	182	24.2	.89(.38-2.10)	.80		
Mode of transport Active (cycling, walking)	17	47.1			NS[b]	
Motorised (car, bus, etc.)	250	26.0	.39 (.14-1.06)	.06		

[a]Adjusted for age, income, and BMI.
[b]Not significant in the final model.
[c]Excluded because of multicollinearity.
[d]Not applicable for regression analysis.

duties of South Asian women were identified as factors limiting participation in PA.[18] This is mainly attributed to the cultural expectations of women to undertake the bulk of domestic duties.[22] Similar to the findings in the present study, previous research also indicates that many South Asian women are unable to use their local leisure centre because of a lack of women-only facilities or activity sessions.[15,54]

Another common barrier to PA was problems with transport to reach facilities. Availability of transport has been shown to be an important access issue for immigrants from culturally and linguistically diverse backgrounds in Australia.[10,19,20] The geographic proximity of appropriate PA facilities to public transport can reduce transport issues and promote social inclusion for different types of physical activities.[19] The most common internal barriers to PA reported by participants were enjoyment and a lack of proper skills and training. Research suggests that a lack of cultural focus on PA from childhood may impact the development of PA habits, long-term behaviours, and skills.[18,31] Some of the other barriers reported in our study (eg, costs, lack of childcare, and weak intention) were similar to barriers reported by other ethnic groups in Australia.[32,39,55] There is a need for targeted and culturally appropriate public health strategies that can overcome the barriers PA immigrants face in Australia.

Socioeconomic factors influence PA and SB in South Asian immigrants.[45,56,57] In the present study, insufficient PA was more prevalent among the middle-class income group. Conversely, a curvilinear relationship was found between high sitting time and socio-economic status.[58] Immigrants belonging to the middle-income group were more likely to sit longer than immigrants from the high- and low-income groups.[58] This may be due to the nature and number of jobs among immigrants from the middle-income group. For example, immigrants whose jobs involve sitting for long periods, either at a computer or a desk, have a higher prevalence of insufficient PA.[58] In addition, immigrants from middle-class income groups tend to have more than one job and engage in less PA during their leisure time.[59] Low-income groups are more likely to have lesser-skilled manual jobs which may provide opportunistic PA, whereas high-income groups easily afford leisure physical activities to minimise their sitting time.[22,45] Studies also found that South Asian immigrants interpreted job-related activities as alternatives to PA participation, which could also increase their sitting time.[58]

Statements	Agreed (%)	Disagreed (%)
Taking the stairs at work or generally being more active for at least 30 minutes each day is enough to improve your health.	41	59
Half an hour of brisk walking on most days is enough to improve your health.	64	36
To improve your health, it is essential for you to do vigorous exercise for at least 20 minutes each time, three times a week.	69	31
Exercise doesn't have to be done all at one time blocks of 10 minutes are okay.	52	48
Moderate exercise that increases your heart rate slightly can improve your health.	64	36

FIGURE 2 Percentage of people agreeing with physical activity awareness health statements ($n = 321$).

Despite South Asian immigrants participating in less PA than non-immigrants, most immigrants (72%) reported that their PA levels increased after migration. This may be explained by differences in awareness of and cultural beliefs about PA among immigrants.[60] For example, South Asians consider domestic duties and related activities to be substituted for moderate PA, and these activities increased after the migration.[16] Only 28% of respondents reported a decrease in their PA levels after moving to Australia, which can be attributed to the lack of cost-effective and culturally appropriate PA facilities.[15] Findings from the present study also revealed differences in PA awareness and knowledge among the participants. For example, over half of the participants failed to acknowledge the importance of taking the stairs. Linguistic factors also significantly influence how PA knowledge is understood, conceptualized, and practised by immigrants from different backgrounds.[23] Basic education sessions provided by individuals from the same culture with linguistic concordance are a suggested strategy for helping immigrant groups learn about the benefits of preventive health measures.[13,24] Evaluating and categorising existing knowledge in a culturally appropriate framework could also improve PA awareness.[60]

This study provides basic information about the prevalence, barriers, and high-risk factors of insufficient PA in South Asian immigrant adults living in Australia. However, findings should be interpreted by acknowledging the limitations of the study. The main limitation was the small and non-representative sample from different cities in Australia. Also, prevalence data were self-reported and vulnerable to

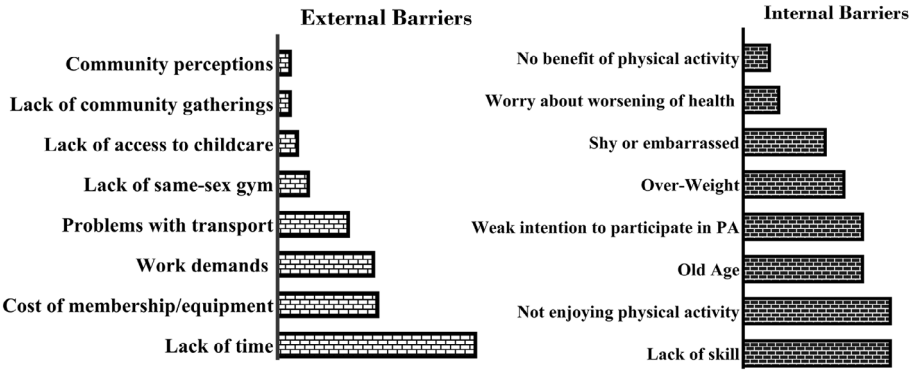

FIGURE 3 Perceived internal and external barriers to participating in physical activity.

biases, although questionnaire data for the prevalence of PA and SB were pre-validated and used previously.[38,39] Another limitation was the survey tool being in English and may represent only English-speaking segment of the South Asian immigrants, living in Australia. Of the 460 participants who attempted the online survey, only 321 provided complete PA and SB responses. It is possible that participants with limited English language proficiency struggled to complete the survey and were excluded from contributing data. A major investment in future longitudinal studies involving immigrant groups is needed to gain a better understanding of PA and SB among immigrants in Australia. A closer examination of activity patterns and sedentary habits among immigrants from different socio-economic backgrounds would be a valuable addition and logical extension to this research and could provide significant contributions to existing literature. Interventions promoting PA and reducing sitting time for immigrants should encompass community settings and participation, integrate ethnocultural linguistic expressions and acknowledge and address barriers to PA.

5 | CONCLUSIONS

Findings from this study showed that most South Asian immigrants in Australia are not participating in sufficient levels of physical activities. A range of individual and environmental barriers, including socio-demographic, cultural, and health-related factors, were associated with SBs in South Asian immigrants. It is possible that major barriers to PA could be reduced through affordable and appropriate facilities being established in close proximity to the target population. Intervention programs that encourage group exercise with people of the same gender should be implemented to decrease long-term sedentary habits in immigrant groups. Cultural expectations, mode of travel and work-related activities should also be considered as part of the overall PA recommendations to reduce the pressure associated with busy schedules and ensure current PA participation and low sitting time. Health professionals could also disseminate culturally appropriate PA knowledge to immigrants to help raise awareness and address health concerns. Overall, advice and future interventions should be customised with stronger inter-organisation collaboration between health care providers and the community to improve habitual levels of PA and reduce SB among South Asian immigrants in Australia.

CONFLICT OF INTEREST STATEMENT

There have been no conflicts of interest and financial support associated with this publication.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

INFORMED CONSENT STATEMENT

Informed consent was obtained from all individual participants included in the study.

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