

1 Decreasing physical activity levels across religious Sikh male 2 South asian migrant population in Kent, UK: A public health 3 concern

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15

16 **Abstract:** Physical activity (PA) plays a crucial role in reducing the risk of non-
17 communicable diseases (NCDs). We investigated intergenerational physical activity level
18 (PAL) among first and second generation Sikh Punjabi male subjects (n=137), recruited
19 from two Sikh temples in Medway, UK. Employing a cross sectional survey PA was
20 quantified using the validated Global PA Questionnaire (GPAQ). Data were analysed using
21 SPSS 20 and Epi Info software. 91% of the subjects were classified as overweight. Mean
22 physical activity level (PAL) range was sedentary to low levels of PA (1.45 – 1.60).
23 Comparisons between first and second generation Punjabi male subjects showed that the
24 two groups are equally culpable in not engaging in work-related or recreational PA, but for
25 the second generation this is significantly lower. Low PAL is a contributory factor to
26 increased risk and prevalence of NCDs among this population and a public health concern.
27 Efforts to increase PA in this group should continue.

28 **Keywords:** South Asian; intergenerational; acculturation; Indian, Nutrition transition

29

30 1. Introduction

31 Physical activity (PA) can reduce the risk of premature death from cardiovascular disease and type 2
32 diabetes and sustain a healthy lifestyle [1]. Physical inactivity is associated with increases in serum
33 insulin and insulin resistance, triglycerides, BMI and increased risk of hypertension [2]. In the UK 150
34 minutes per week of moderate activity or 75 minutes per week of vigorous activity to attain the
35 beneficial effects of PA are recommended [2, 3]. Exercise for 30 min/day to 60 min/day helps to
36 reduce total and abdominal fat and improve metabolic profiles [4]. Moreover, PA can independently

37 improve serum lipid profile by reducing triglycerides, LDL cholesterol and total cholesterol and
38 improving HDL cholesterol levels and thus help to reduce cardiovascular risks [5,6,7]. Increase in PA
39 and lifestyle modification have shown a reduced risk of diabetes [6].

40

41 South Asians (those with ancestral origins from Pakistan, India, Bangladesh and Sri Lanka) living in
42 the UK have consistently been shown to have lower levels of PA than the general population [8, 9].
43 This trend begins in early life [8, 9, 11] and is likely to be an important contributor to an increased
44 incidence of cardiovascular disease (CVD), diabetes and poor health outcomes observed in this group.
45 Obesity is associated with increased risk of CVD and diabetes [7,10-13] and it is of concern that the
46 incidence of obesity is high among SA.

47

48 Research indicates several factors, distinct to UK South asians (SA), which may impact on their PA
49 levels [9-11]. Migration histories indicate that SA born in the UK report higher levels of PA than those
50 born elsewhere [30]. Williams et al report total Metabolic Equivalent of Task (MET-min/week) were
51 consistently lower in UK SA than in white participants (973 versus 1465 MET-min). This ethnic group
52 difference was consistent across gender, age groups and subgroups and was independent of covariates
53 [14, 30]. Self-reported PA patterns in SA suggest that nearly 35% of SA men were doing office
54 service-based jobs a decade ago, (mainly seated) with commensurately low levels of PA undertaken [5,
55 6]. Moderate PA such as light lifting, climbing stairs and outdoor hill walking is low among SA men
56 compared to Europeans [7, 9]. Low preference for walking and cycling is common among SA men.
57 Previous studies have suggested that in comparison with the general population, overall participation
58 in sports and recreational activity was less among SA men [11]. Furthermore, among the minority
59 ethnic groups in England, SA were found to be living the most sedentary lifestyles [10]. Comparisons
60 between SA subgroups in the UK showed that Bangladeshis were the least physically active followed
61 by Pakistani's and those of Indian origin. Only 17% of Indians, 16% of Pakistani's and 10% of
62 Bangladeshi's met current PA recommendations [8]. Overall, motivation and encouragement to
63 engage in PA for a healthy life is found to be low among this population.

64

65 Acculturation and assimilation is described by Jamal [15] as unidirectional and describes the change
66 processes that immigrants undergo once they leave their country of origin and adapt to a new country
67 [15]. Many changes take place during this process, particularly in PA and dietary patterns. SA
68 migrating from their "home" country experience changes in dietary intake and in PA. There is
69 currently little evidence of changes in PA levels amongst SA group, based on acculturation for first
70 generation and occurrence for second generation SA. Previous research indicates that Punjabis living

71 in the Punjab state of India have the highest rates of overweight and obesity compared to other states
 72 of India [27]. We therefore sought to examine the PA level of a parallel group living in the UK to
 73 ascertain if the picture is similar and whether any intergenerational differences occur.

74

75 Thus the research aimed to:

- 76 ○ Assess current levels of PA in a Sikh Punjabi male population living in Medway, Kent (UK)
 77 and compare this to current recommendations.
- 78 ○ Compare levels of PA between first and second generation Sikh Punjabi males living in
 79 Medway.

80 **2. Methods**

81 *PA Level Assessment*

82 The study employed a cross-sectional survey method. To test our hypothesis of intergenerational
 83 differences in relation to levels of PA and risk of non-communicable diseases (NCDs), the WHO
 84 Global PA Questionnaire (GPAQ) was used to measure PA among this group [17,18]. GPAQ is an
 85 indirect method of PA measurement validated by Bull, et al. [26] for universal use enabling national,
 86 regional and global comparisons to be made. The questionnaire enabled three domains of PA to be
 87 measured, namely occupational, transport (to and from work) and recreational activity utilizing 16
 88 questions. Data collected was converted into *MET equivalents* where 1 MET equals the energy cost of
 89 sitting quietly without undertaking much activity *i.e.* a completely sedentary scenario [19]. Data
 90 analysis was undertaken following GPAQ analysis guidance provided by WHO STEPS [18]. This was
 91 further quantified as equivalent to the consumption of 1 kcal/kg/hr. To estimate the energy costs of
 92 sleeping and sitting, the Schofield Equation [19] was used. In this study, this equation was applied to
 93 help quantify (by estimation using the prediction equation and taking into account time spent per
 94 activity) energy expenditure (EE) due to sitting and sleeping. Physical activity level (PAL) was
 95 calculated using WHO/FAO predictive equations based on physical activity ratios (PAR) of the
 96 various components of daily activity []

97

98 *Sample Size Calculation*

99 Sample size was calculated based on the use of the following provisions: a statistical power of 90% (1
 100 - $\beta = 0.9$) was sought with a medium effect size $\rho = 0.30$ and Type I error ($\alpha = 0.05$) with non-centrality
 101 parameter δ of 3.28; using a point biserial model to allow for t-tests and correlation (two tailed). The
 102 sample size computed = 109 [16]. Allowing for recruitment and retention difficulties for ethnic
 103 minorities previously reported [29] and assuming an attrition rate of 25%, based on experience from

104 our pilot study, the total sample size calculated was $n=136.3$. A total of 137 subjects were therefore
105 recruited to participate in the study.

106

107 *Sampling and recruitment*

108 Subjects were identified and recruited from two local Gurudwara (Sikh temple), in the Medway town
109 chosen for their general as well as religious use. There are no known differences between the two
110 temples as the congregation was similar in interest and religious background. The static numbers of
111 temple attendees were obtained from temple registrations. 565 adult males aged between 20 and 60
112 years who were attendees at both Sikh temples met the eligibility criteria to participate. Two cohorts
113 were recruited. Cohort A (from Gillingham Gurudwara) $n=325$; and cohort B (from Rochester
114 Gurudwara) $n=240$ respectively to form the combined total for the study population. In total 225 (out
115 of 565 possible) subjects were recruited using a random stratified sampling procedure from Rochester
116 $n=113$; and Gillingham $n=112$. In this process males from Punjabi origin were selected and for
117 stratification Sikhs were selected at random and screened for eligibility and selection to participate in
118 the study using inclusion/exclusion criteria identified in **Table 1**. Of this number, eighty-eight ($n=88$)
119 were excluded and one hundred and thirty-seven ($n=137$) were eligible for inclusion in the study and
120 were assessed for PA using the global PA questionnaire (GPAQ). Sixty-eight ($n=68$) subjects from
121 (Rochester and sixty-nine from Gillingham were recruited from each temple via a simple random
122 procedure involving Sikh male subjects within the specified age range, giving a final sample size of
123 one hundred and thirty seven ($n=137$).

124

Table 1: Study inclusion and exclusion criteria

Variables	Inclusion	Exclusion	Remarks
Sex	Male Adults	N/A	As long as they can provide us with dietary intake & food preparation information.
Age	(20-60 years)	<20 or 60>	Identification of diet commonly consumed by this population.
Health status	Apparently healthy individuals with no disorder/disease and therefore, not on restricted diet	Already diagnosed patients with diabetes and/or other chronic NCD	Must be familiar with traditionally consumed diet
Languages (s)	Must be fluent in Punjabi; Able to communicate in basic English	Non Punjabi-speaking; not able to communicate in basic English	
Lifestyle	Any and no restriction on religion	None	
Medication	Must be declared to be included in study	Individuals on current treatment for known NCDs	
Time in the UK	Either born in the UK or resident for ≥ 8 years	excluded Less than <8 years in the UK.	This cut off was used on the basis of time-related lifestyle moderation and adjustment to culture in the UK
Immigration Status	Permanently Resident	Temporary and Visitor	

130 **2.1 Data collection**

131 Subjects were interviewed using the GPAQ; each interview lasted approximately 20 minutes and was
 132 conducted in English with Punjabi translation where required by the bilingual primary investigator.
 133 Interviews took place in a quiet room provided at the Temple study site where subjects were invited for
 134 the study and interviews were undertaken in confidence.

135

136 **2.2 Data handling and analysis**

137 The data was collated, grouped and presented in the form of tables. Data were entered into Microsoft
 138 Excel (2010) and transferred into Statistical Package for Social Sciences version 20 for analysis.
 139 GPAQ data collection was analysed following WHO STEPS, GPAQ V.2 procedure [17,18].
 140 Conversion of 24-hour PA data into MET equivalents by quantify the energy costs of daily individual
 141 activities in kcal/day and kcal/kg/day. GPAQ [17,18,19] data was used to categorize subjects into
 142 different levels of PA *i.e.* Low, Moderate and High activity groups respectively. Contributions of
 143 occupational and recreational PA, in addition to age-related differences in levels of PA were calculated
 144 (**Box 1**).

145 **Box 1:** Calculations used for physical activity level, total daily energy expenditure & METs equivalent

PAL Calculation: {Time Allocation per activity * Physical Activity ratio (PAR/Known as Energy cost of various activity) } ÷ 24 hours

TDEE: Basal metabolic rate (BMR at particular age) * PAL

Energy Intake: (1g Protein * 4 Kcal) + (1g Carbohydrate * 4 Kcal) + (1g Fat * 9 Kcal)

METs equivalent calculation: In this study an individual's energy expenditure was calculated using GPAQ version 2 data, 4 METs is assigned to the time spent in moderate activity and 8 METs to the time spent in vigorous activities.

Types of activity were classified based on GPAQ WHO STEPS analysis guidance [17, 18, 19].

146

147

148 All variables were tested for normal distribution using Shapiro Wilk test. Descriptive statistics were
 149 performed and more specific significance testing using student t-test (both paired and independent)
 150 was employed based on the variable set of significance. Z-tests were conducted to test the significance
 151 of observed differences between the first generation and second generation parameters. Results of
 152 quantitative analyses obtained are presented as means (with standard deviation and 95% confidence
 153 intervals). Intergenerational differences of variables were computed. Differences of means compared
 154 using the Z-test, were considered to be statistically significant at p values of ≤ 0.05 .

155

156 ***Ethics statement***

157 This study was conducted according to guidelines laid down in the Declaration of Helsinki and all
158 procedures involving human subjects were approved by the University of Greenwich, Research Ethics
159 Committee (UREC/10/11.4.5.2). Permission and cooperation was also granted in writing by the leaders
160 (Granti-Ji) at two Sikh temples in Medway, Kent. Subjects provided written informed consent.

161 **3. Results**

162 **Results**

163 ***PA among Male Sikh Punjabi Population***

164 Self-reported PA among adult male Punjabi Sikh migrants (n=137) in Medway, Kent are reported.
165 Comparisons are reported for the total study sample and intergenerational comparisons (between first
166 and second generation subjects). The components of PA including employment/work transport and
167 non-occupational activities (i.e. recreational) and their contributions to PA levels in relation to age
168 groups of five year intervals are presented in **Table 2** quantified in MET-Minutes per week.

Table 2: Physical Activity converted into MET-minutes/week according to activity type (n=137)

Age Groups (years)	Participants Per Group	Activity at Work Vigorous (Mean ±SD)	Activity at work Moderate (Mean ±SD)	Travel to and from work (Mean ±SD)	Recreational Activity Vigorous (Mean ±SD)	Recreational Activity Moderate (Mean ±SD)	Total Met- minutes/ week	BMI Kg/m²
21-25	6	60.00(146.97)	30.00 (73.48)	230.00 (258.53)	220.0 (244.95)	130(179.67)	670.0	30.68(1.41)
26-30	29	70.3 (145.3)	72.4 (163.8)	122.80 (201.0)	66.2 (168.4)	266.9 (215.5)	598.6	28.70(2.96)
31-35	30	48.00 (124.47)	94.00 (160.44)	68.67 (136.12)	84.00 (175.88)	228.00 (189.34)	522.67	27.66(2.08)
36-40	30	38.71 (121.54)	44.52 (92.91)	112.26 (195.80)	77.42 (179.46)	303.87 (208.39)	576.78	28.39(2.43)
41-45	23	15.65 (75.07)	112.17 (180.28)	120.00 (190.60)	41.74 (117.85)	260.09 (211.61)	549.65	28.80(2.42)
46-50	15	16.0 (62.0)	36.0 (74.5)	138.7 (181.2)	72.0 (126.7)	236 (176.3)	498.7	28.32(0.64)
51-55	4	0.00 (0.00)	90 (180.0)	295.0 (224.7)	0.00 (0.00)	120 (84.9)	505.00	27.78(0.69)
Mean(SD)		36 (25.87)	68 (32.01)	155 (78.57)	97 (58.93)	213 (67.70)	552	
95% CI Upper		54.69	92.16	213.54	140.99	263.13	601.06	
95% CI Lower		16.37	44.73	97.13	53.68	162.82	503.91	

171 ***Comparison of Total Daily Energy Expenditure due to different activities across age groups***

172 The quantification of energy costs of individual PA based on the conversion from METs to energy
173 equivalents in kilocalories (*i.e.* 1 MET = 1kcal / kg /hr.) and age-group comparisons is presented in
174 **Table 3**. Activities have been split into various forms based on the GPAQ tool. Energy costs of sitting
175 quietly and sleeping have been included to provide a more complete picture of the total daily energy
176 expenditure (TDEE) estimates for each age-group category and the whole group.

177

178 The age group with the highest work-related energy expenditure (EE) due to vigorous activity was the
179 26 - 30 age group with a mean (SD) of 98.31(204.11) kcal /d. The 51 – 55 age group had no work-
180 related nor recreational vigorous activity recorded. The overall group mean (SD) was 56.15 (159.45)
181 kcal/day from work-related vigorous PA with a 95% CI of 29.54, 82.75.

182

183 Energy costs of work-related moderate PA, show that the age group with the highest energy
184 expenditure was the 31 – 35 years' age group with a mean (SD) of 281.63 (454.00) kcal/day. The 21 –
185 25 age group had the lowest work-related energy expenditure with a mean value of 43.75 (107.17)
186 kcal/day. The whole group mean (SD) EE from work-related moderate activity was 173.76 (324.58)
187 kcal/day. Very wide SD values are observed throughout most of the age groups reflecting the lack of
188 consistency in individual engagement in PA, of any type, at work as captured by the GPAQ.

189
190

Table 3: Total Daily Energy expenditure (EE) Kcal/ day due to various types of activity according to activity type (n=137)

Age Groups (years)	Activity at Work Vigorous (Mean ±SD)	Activity at work Moderate (Mean ±SD)	Travel to and from work (Mean ±SD)	Recreational Activity Vigorous (Mean ±SD)	Recreational Activity Moderate (Mean ±SD)	Sitting (Mean ±SD)	Sleeping (Mean±SD)	TDEE (Kcal/ day) (Mean ±SD)
21-25	87.50(0.00)	43.75(0.00)	368.07(411.92)	342.97(388.18)	218.67(303.33)	1255.80(97.84)	691.35 (68.84)	3008.10(229.73)
26-30	98.31(204.11)	108.15(249.40)	258.57(385.21)	241.38(384.38)	532.78(341.76)	1140.64(120.66)	590.10(106.44)	2969.93(509.50)
31-35	61.56(159.73)	281.63(454.00)	132.92(265.49)	188.39(350.87)	478.22(321.37)	1082.81(104.94)	533.32(115.68)	2778.86(394.28)
36-40	55.66(175.63)	126.09(257.96)	231.56(473.52)	158.81(355.98)	610.11(342.88)	1137.54(139.94)	566.02(133.21)	2885.79(260.74)
41-45	18.21(87.33)	274(360.69)	169.05(274.35)	115.43(276.14)	516.74(389.73)	1093(99.48)	568.09(83.32)	2755.33(484.09)
46-50	25.41(98.43)	95.95(215.52)	274.38(329.71)	160.65(327.00)	512.85(445.07)	1139.75(109.16)	622.75(69.78)	2831.74(510.22)
51-55	0.00(0.00)	117.30(234.60)	649.49(253.71)	0.00(0.00)	156.40(312.80)	1074.45(66.80)	532.63(73.86)	2693.34(355.94)
Mean	56.15(159.45)	173.76(324.58)	228.08(366.32)	183.50(342.99)	509.08(360.01)	1122.47(119.73)	579.31 (109.51)	2852.35(512.39)
95% CI Upper	82.75	227.91	289.19	240.73	569.14	597.58	597.58	2937.84
95% CI Lower	29.54	119.61	166.96	126.27	449.01	561.04	449.01	2766.86
p-value	0.001	0.012	0.017	0.014	0.001	0.128	0.147	0.023

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194 *Estimation of Energy Balance and their Association with PA Level (PAL)*

195 A summary of total daily energy intake (EI, Kcal / day) estimated from pooled means of three 24-hour
196 dietary recall data are presented in **Table 4**. Total daily energy expenditure (TDEE, Kcal / day) based
197 on calculations from GPAQ data (for occupational, travel and recreational PA) and using Schofield's
198 equation [19] (for energy costs of sitting and sleeping) are also presented. From these data, estimates
199 of energy balance i.e. EI – TDEE have been calculated and the group comparisons are presented to
200 indicate whether the subjects were in positive (i.e. > +1Kcal / day) or negative (i.e. < 0 kcal /day)
201 energy balance (EB) based on intake/ expenditure.

202

203 The data in **Table 4** show that all age groups were in positive energy balance except for the 46 – 50
204 age group which was in negative energy balance but with a very large SD value showing wide intra-
205 group variation. All age groups had excess energy intake over expenditure (EB) of at least 300 kcal
206 per day with the exception of the 51 – 55 age group with mean (SD) EB of +8.33 (1553.21) kcal / day.
207 The highest EB was recorded in the 21 – 25 age group with mean (SD) of 661.42 (956.92) kcal / day
208 followed by the 31 – 35 and 26 – 30 age groups with mean (SD) values of 516.60 (1047.88) and
209 514.21 (1515.42) kcal / day respectively. The whole group mean (SD) EB was 363.93 (1307.99) kcal /
210 day representing excess intakes with a 95% CI of 145.70, 582.17.

211

212 The reference cut-off points for classification of individuals (and population groups) as sedentary is
213 PAL ranges from 140 – 169. The PAL values presented in **Table 4** ranged from 1.53 (0.06) in the 41 –
214 45 age group to 1.64 (0.06) in the 51 – 55 age group. The overall group mean (SD) PAL value of 1.54
215 (0.07) is confirmatory of a sedentary population with a 95% CI of 1.52 – 1.55. There was no
216 significant variation in PAL among the groups (single factor ANOVA, p=0.783).

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Table 4 Daily Energy Intake, Expenditure and PA levels (PAL) of a Punjabi adult male population in Medway, Kent (n=137)

Age Groups (years)	EI (Kcal/ day) Mean (±SD)	Median	TDEE (Kcal/ day) (Mean ± SD)	Median	Energy Balance (EB) Kcal (Mean ± SD)	PAL Value (Mean ± SD)	Median	PAL Level*
21-25	3669.53(932.19)	3703.99	3008.10(229.73)	3336.50	661.42(956.92)	1.56 (0.08)	1.55	Sedentary
26-30	3484.13(1418.40)	3696.22	2969.93(509.50)	3036.33	514.21(1515.42)	1.54 (0.08)	1.49	Sedentary
31-35	3295.45(999.09)	3389.11	2778.86(394.28)	2735.32	516.60(1047.88)	1.52 (0.06)	1.49	Sedentary
36-40	3225.16(1076.08)	3462.11	2885.79(260.74)	2830.24	339.37(1390.92)	1.54(0.09)	1.49	Sedentary
41-45	3115.54(1115.13)	3180.97	2755.33(484.09)	2818.10	360.21(1246.45)	1.53(0.06)	1.49	Sedentary
46-50	2632.12(1420.31)	2131.50	2831.74(510.22)	2908.97	-199.62(1389.45)	1.55(0.07)	1.50	Sedentary
51-55	2701.67(1246.94)	2701.67	2693.34(355.94)	2991.65	8.33(1553.21)	1.64(0.06)	1.63	Sedentary
Mean	3216.28(1191.64)	3279.64	2852.35(512.39)	2904.21	363.93(1307.99)	1.54(0.07)	1.49	Sedentary
95% CI			2937.84		582.17	1.55		
Upper 95% CI	3405.08							
Lower 95% CI			2766.86		145.70	1.52		
p-value	0.037		0.023		0.032	0.783		

221

222 **Intergenerational Comparisons of Energy Intake and Expenditure**

223 The PAL values in **Table 5** show that both first and second generation Punjabi males in Kent are
 224 sedentary with equal PAL of 1.54 (mean SD +/- 0.07). Total daily energy intake (EI) was significantly
 225 different between first and second generations. The mean (SD) EI was 3079.04 (1174.97) kcal/day in
 226 the 1st generation and 3517.95 (1186.08) kcal/day in the 2nd generation (p=0.045) with a difference in
 227 means (95% CI) of 438.21 (5.681, 870.74). Differences in the magnitude of total daily energy
 228 expenditure (TDEE) between the 1st and 2nd generation were observed. These differences were not
 229 statistically significant (p=0.085). However, despite this both the 1st generation and 2nd generation are
 230 sedentary.

231 **Table 5** Age and inter-generation differences in PA and energy balance

Variables*	Generations		Difference in Means	95%CI Lower	95% CI Upper	p- value	Group (n=137)	
	1st (n= 43) Mean (±SD)	2nd (n=94) Mean (±SD)					Mean (±SD)	Median
PAL	1.54(0.07)	1.54 (0.07)	0.0031	-0.024	0.0304	0.819	1.54(0.07)	1.49
TDEE (Kcal/day)	2803.59(524.91)	2960.05(471.67)	156.45	-22.06	334.98	0.085	2852.35(512.39)	2904.21
EI (Kcal/day)	3079.73(1174.97)	3517.95(1186.08)	438.21	5.681	870.74	0.045	3216.28(1191.64)	3279.64
EB (Kcal/day)	276.14(1329.24)	557.89(1253.07)	281.75	-184.96	748.47	0.256	363.93(1307.99)	333.04
BMI (Kgm ⁻²)	28.3(2.2)	28.69(2.63)	-0.368	0.550	-1.287	0.475	28.44(2.34)	28.22

232 *PAL = PA Level; * TDEE= Total Daily Energy Expenditure; * EI = Energy Expenditure; *EB
 233 = Energy Balance

234
 235 Energy balance (i.e. EI – TDEE) comparisons showed that 2nd generation had a higher EB of 557.89
 236 (1253.07) than the 1st generation whose EB was 276.04 (1329.24). The difference in means (95% CI)
 237 was 281.75 (-184.96, 748.47). These differences suggest that both groups expend energy to similar
 238 extents. However, the 2nd generation’s energy intake significantly exceeds that of the 1st, and that is
 239 the main source of difference between these two largely sedentary inter-generational groups in this
 240 male genetically, culturally and religiously homogenous population. Type of occupation among the
 241 Sikh Punjabi population living in Medway is presented in **Table 6** and indicates largely sedentary
 242 activity by the majority.

244 **Table 6** Type of occupation* among Sikh Punjabi male population living in Medway, Kent, UK

Occupation Type	Activity Type	Total (n=137)	% Occupation Type
Retired / Not working	Nil	0	0%
Administrative Office	Sedentary	66	73% Sedentary
Business	Sedentary	35	
Builder/developer(Manual Worker)	Active	29	
Manual Labour	Active	7	27% Active

245 *Types of occupation is based on international standard classification of occupations ISCO-08 [31]

246

247 **4. Discussion**

248 The present observational study of a cohort of Indian Punjabi Sikh males (age 20 to 60) have lower
 249 energy expenditure, a lower PAL, than expected and are engaged in largely sedentary-type jobs. PA is
 250 an independent risk factor for NCD's and it has been reported that PA, especially moderate to high PA
 251 may reduce the risk of cardiovascular disease by half [20,21]. Using WHO recommendations a PAL
 252 of 1.70 to 1.99 is expected for this population group which equates to moderately activity. The
 253 findings show the range of PAL is 1.45 – 1.60, which classifies the entire sample as sedentary or
 254 involved in low levels of PA (as supported by existing literature).

255

256 More importantly, comparisons between first and second generation migrants unique to this study
 257 show that the two generational groups are equally culpable in not engaging in PA, be it work-related or
 258 recreational and are falling short of the current UK Department of Health recommendation for PA [3].
 259 Furthermore, the MET-Minutes per week estimations provide average values for the whole sample
 260 which falls short of 600 MET-Minutes per week *ie* the threshold for sedentary activity. This low level
 261 of PA puts this population at a higher risk of NCDs [24, 25].

262

263 This population of Punjabi males in the UK when compared to their age-matched cohorts in the Indian
 264 and Pakistani Punjab, are more engaged in ‘sedentary’ service type jobs (about 73% of the sample
 265 population) and only 27% engage in manual labour of significance. In comparison, those of a similar
 266 age range in the Indian Punjab are mostly engaged in agricultural type manual labour (70%) compared
 267 to service industry type jobs (30%) [22,23,26]. The Indian national statistics observe that the Punjab
 268 Province has the highest rate of overweight and obese people at just over 30% in the whole of India, in
 269 a country where 70% of the population is purported to be engaged in manual labour [27].
 270 Additionally, PA due to transport (e.g. walking, cycling to and from work) is likely to be much higher
 271 in India than among their counterparts in the UK [25].

272 Energy intake and expenditure comparisons (**Table 4**) show clearly that this population is in positive
273 energy balance across the different age groups and both generations. The second generation has a
274 significantly higher energy intake ($p=0.045$) compared to the first generation and have a higher BMI
275 (**Table 2**) although the latter differences were not statistically significant. Both groups have BMI
276 values above 28 kgm^{-2} and 91% of the subjects are at least overweight (using normative BMI cut-off
277 criteria). However, there is growing evidence to suggest that at lower BMI people of Indian origin
278 have a much higher cardiovascular and non-communicable disease risk compared to Caucasians and
279 therefore the risk is greater [24, 25, 28, 29]. Using the Asian specific cut-off points developed for BMI
280 [32] more of this group would be classified as overweight and obese.

281
282 Concerns about low PA among the SA migrant population have been previously expressed [8,9,10,11]
283 although these studies have limitations. Importantly, this study finds that the second generation UK
284 Sikh Punjabi male is less physically active than the first generation, a result which is contrary to that
285 previously reported [10]. Furthermore, given the three-fold increase in the prevalence of overweight
286 and observed in the sample population (compared to their aged-matched cohorts in the Punjab, India),
287 of particular importance as a risk factor is the possible impact of long term migration and a change of
288 environment on physical growth, food-related behaviours, occupational differences and sedentariness
289 in this homogeneous migrant adult male population, originating from the Indian Punjab and domiciled
290 in the UK.

291
292 It is clear from this research that there are intergenerational differences in PA levels in a homogeneous
293 group of migrant male adults, and despite differences in social exposure e.g. education, social mobility,
294 employment in incomes, we cannot assume the second generation will be more active as they are
295 influenced by other motivators or barriers to PA including the environment. This may be suggestive of
296 the closely linked nutrition transition observed across the world, including India [30]. The very types
297 of occupation and low levels or work-related PA especially among the second generation underscores
298 a need to examine ways to address overweight and obesity risks through targeted work-based
299 interventions.

300
301 Cultural barriers have been implicated as one of the barriers to PA among SA females [1] in relation to
302 cultural barriers which may in themselves influence parental encouragement and promotion of PA
303 among their growing female children, which may similarly be the case for a physically inactive father
304 – although there is no evidence to support this for south Asian males. Whilst some social-cultural and
305 environmental barriers to increasing physical activity may be common among the SA communities in
306 the UK, they are by no means unique or exclusive. Indeed, Jepson et al [1] suggest that interventions

307 should focus on motivations rather than the well documented barriers. This includes group based
308 activities, an approach which has also been successful in dietary change in relation to obesity and
309 weight management elsewhere.

310

311 This research has a number of limitations due to the potential bias of the sample and thus the limited
312 external validity restricting its application to a general population. However, it does present a useful
313 contribution to the development of our knowledge of PA patterns in this often hard to research group
314 of participants in the UK.

315

316 Tackling the problem of obesity and chronic disease risk in population groups such as this one would
317 require concerted, culturally and religiously targeted, focused and contextualized behaviour change
318 programs including physical activity, lifestyle coaching and dietary behaviour change activities in
319 convivial community settings such as temples which provide an opportunity to reach target groups.
320 The successful recruitment of males in this study through the medium of a religious environment *i.e.* a
321 Sikh temple, suggest that this is a useful place to develop and deliver such interventions for maximum
322 outreach and impact.

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326 **Author Contributions:**

327 Conceived and designed the study: SS, PA and ZBF. Reviewed the methodology and analysis: PA,
328 FBZ, BE. Performed the data collection and analysis: SS. Interpreted the findings: SS, PA, FBZ, BE.
329 Wrote the paper: SS, BE. All authors edited and approved the final manuscript.

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