Geographical Patterning of Physical Activity Prevalence in Iran: Spatial Analysis of 4 Pooled National Health Surveys Among 119,560 Adults

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Background: To investigate the geographical distribution of physical activity (PA) prevalence among adults aged 15–64 years old across Iran provinces using geographic maps. **Methods:** Data from 4 consecutive national surveys conducted between 2007 and 2010 were pooled to determine the geographical distribution. Prevalence of low PA with 95% confidence interval was estimated by sociodemographic subpopulations over provinces using complex survey design. **Results:** In total, 119,560 participants (49.9% females) were included in the analyses. The mean (SD) age of participants was 39.5 (14.3) years. The prevalence of the low PA in the pooled 2007–2010 was 35.8% (95% confidence interval, 34.1–37.6). The 3 provinces with the highest prevalence of low PA were Sistan and Baluchestan, Yazd, and Hormozgan. The results of hot spot analysis showed that the Kerman province was a hot spot, and Ilam, Kermanshah, Hamedan, and Markazi were cold spots for low PA. Ilam, Kohgiluyeh and Boyer-Ahmad, and Mazandaran had the highest total PA volume (metabolic equivalent minutes per week). Hot spot analysis showed that Ilam and Khuzestan provinces were hot spots for the total PA volume. **Conclusions:** The regions with low and high PA are predominately situated in the near center/southeast and west, respectively.

Keywords: epidemiology, national step survey, geographical pattern, exercise

Physical activity (PA) has well-established health benefits; low PA level is one of the most prevalent risk factors for noncommunicable disease worldwide. Regular PA has been shown to prevent cardiovascular diseases, type 2 diabetes, some cancers, hypertension, obesity, and depression; studies have also shown that low PA is considered a major risk factor for disability and is associated with significant economic burden in the world.^{1–3}

According to a report by the general assembly of the World Health Organization in 2017, there has been little progress with reducing the burden of noncommunicable diseases. Reducing the prevalence of low PA requires a coordinated and long-term global action plan.⁴

The prevalence of low PA in the world is estimated to be 21.4%, which varies from 2.6% to 63.3% according to wealth and

development status across countries. According to the latest national study on risk factors of noncommunicable diseases in Iran in 2011, the prevalence of physical inactivity among adults increased from 35% in 2007 to 39.1%.^{5,6} In the systematic review carried out by Fakhrzadeh et al,⁷ the prevalence of low PA in Iran is high and ranges from 30% to 70% in different studies.

Low PA has been identified as the fourth cause of global death (6% of deaths globally). Furthermore, low PA has been shown to contribute to 21%–25% of breast and colon cancers, 27% of type 2 diabetes, and roughly 30% of ischemic heart disease burden.⁸

Understanding the geographical distribution of PA can help prioritize distribution of health resources within countries and to potentially improve their effectiveness.^{9,10}

Spatial analysis is used to examine distribution patterns of a health outcome, behavior, or population characteristic. Such analysis can reveal if differences among regions are random or occur at a consistent geographical pattern. Also, if such patterns exist, they will be detected with quantitative measures.^{11,12} Examining PA patterns using geographic information systems (GIS) can inform national PA policy by identifying target areas with low PA.^{13,14}

To the best of our knowledge, no spatial analysis of PA patterns of the Iranian population has been published. The aim of this population-based study was to investigate the distribution of PA prevalence across different provinces of Iran using geographic maps.

Methods

The Study Area

Iran, a country in the Middle East with the extent of 1,648,195 km², has been ranked as the 17th largest country in the world with a population of over 75 million (2011). It possesses a number of

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unique environmental and topological features, such as vast length and breadth, topographic diversity, and large variation in altitude including a peak of 5671 m above sea level. Iran has been currently divided into 31 provinces.¹⁵

Data Source

In this cross-sectional population-based study, we merged the data obtained from 4 consecutive rounds of national surveys, which were carried out from 2007 to 2010 in Iran. Approximately 30,000 noninstitutionalized Iranian people aged 15–64 years were recruited in each survey. Respondents were 119,560 individuals between 15 and 64 years old who had valid PA data. Participants were sampled using stratified cluster random sampling techniques, with the provinces were defined to be as strata. Random samples of 1000 individuals were selected from each stratum. The primary sampling units were assumed as blocks of buildings in both residential areas (rural and urban) and were chosen randomly from the list of postal codes provided by Iran's postal service (10 digits), based on a systematic sampling method. A cluster consisted of 20 individuals, 2 males and 2 females in each age group (ie, 15–24, 25–34, 35–44, 45–54, and 55–64 y), and assessors interviewed households in each block until the clusters were completed. The detailed methodology of the survey sampling has been described previously.¹⁶ This study was approved by institutional review board of Tehran University of Medical Sciences with ethics committee code: IR.TUMS.SPH.REC.1395.514.

Physical Activity

Self-reported PA was measured using the Farsi (or Persian) version^{17,18} of the Global PA Questionnaire (GPAQ, version 2)¹⁹ developed by World Health Organization. GPAQ has demonstrated acceptable validity and reliability for evaluating PA in a national surveillance medium-income country. The questionnaire includes 16 questions to assess the PA, in moderate and vigorous intensity, in 3 domains: during working, commuting, and leisure times.²⁰ The GPAQ assessed participation in moderate-intensity and vigorous-intensity activities, and time spent in sedentary behavior (watching television, sitting and, resting) on an ordinary day. Energy expenditure was calculated using metabolic equivalents (METs) values of each reported activity.²¹ Moderate-intensity and vigorous-intensity activities were assigned 4 METs and 8 METs, respectively.¹⁹ Total PA (TPA; MET minutes per week) was considered as the sum of all METs multiplied by work, transportation, and recreation times per week.²² Further details on GPAQ can be found in other published sources.^{19,20}

According to GPAQ framework,¹⁹ the PA levels were classified as follows:

“High level: Vigorous intensity activity in 3 days with a minimum total expenditure of 1500 MET-min/week; or a mixture of activities, such as walking and moderate/vigorous-intensity activities in at least 7 days with at least consumption of 3000 MET-min/week.

Moderate level: Persons who did not match the criteria for the high level and who reported vigorous intensity activity for at least 20 minutes in 3 or more days per week; or moderate intensity activity or walking for at least 30 minutes on 5 or more days per week; or any mixture of vigorous or moderate intensity activity or walking with minimum 600 MET-min/week.

Low level: Persons not classified in any of the previously mentioned groups come at this level.”

Statistical Analysis

Questionnaire data were collected according to the World Health Organization STEPwise guideline for health surveillance studies.²² The gathered data were analyzed on August 2018. The multistage sampling design was taken into account using standard complex survey analysis method. We applied inverse probability weighting and linearized (robust) standard error to adjust for unequal probability of selection and clustering, respectively (but not frequency weighting), which does not increase the sample size.²³ We determined the final weight by multiplying the subsequent weights: First, sampling weight that is the inverse probability of each subject sampling and second, nonresponse weight that is the inverse probability of response in each sex–age group.

Continuous variables were summarized as median (interquartile range), and categorical variables were presented as number (percentage). The overall prevalence of each level of PA (low, moderate, and high) and mean of METs with 95% confidence intervals were reported. All the analyses were performed using Stata (version 12; Stata Corp, College Station, TX), and all maps were generated using ArcGIS Desktop (version 10.1; ESRI, Redlands, CA).

Hot Spot Analysis

For hot spot analysis, the most recently updated electronic map of Iran was linked to the Excel file that contained prevalence of PA for Iran's provinces. Then, to assess the presence of spatial-clustering, Getis-Ord G_i^* statistic score was calculated for each province based on Equation 1 and was compared with its corresponding expected value. Then, a province is considered hot/cold spot if its G score is greater than or less than its expected value. Indeed, this difference needs to be more than to be justified by random error to be statistically significant.^{16,24–26} This means that if the province has a difference of its expected difference of more than +1.96 and –1.96, then the province is considered a significant hot/cold spot, and if the difference is between –1.96 and +1.96, then the province is considered nonsignificant.

The expected values are defined based on Fixed Distance Band method. According to this method, the expected value of a province is calculated as the weighted average of the observed values of its neighboring provinces within a specified critical distance range in a way that nearer provinces receive a higher weight. For determination of critical distance, we used the Euclidean distance method; that is, the straight and minimum distance between 2 polygons center. Center of polygons is determined by the centroid method.²⁶

$$G_i \cdot \text{Statistics} = \frac{\sum_{j=1}^n W_{ij} X_j - X \sum_{j=1}^n W_{ij}}{S \sqrt{\left[\frac{n \sum_{j=1}^n W_{ij}^2 - (\sum_{j=1}^n W_{ij})^2}{n-1} \right]}} \quad (1)$$

Equation 1: Getis-Ord G_i^* (G_i^* Statistics), where X_j is the incidence of PA for province j , W_{ij} is the spatial weight between province i and j , and n is the total number of provinces.

Results

The study sample comprised 119,560 individuals; 50.1% were males and 49.9% were females. The response rate was 90% for each survey. The mean (SD) age of participants was 39.5 (0.04)

Table 1 The Characteristic of the Population Under Study From 2007 to 2010 (Crude/Unweighted Percentages), N = 119,560

Variables	n (%)
Age group, y	
15–24	24,188 (20.23)
25–34	23,930 (20.02)
35–44	23,958 (20.04)
45–54	24,028 (20.10)
55–64	23,456 (19.62)
Sex	
Male	59,794 (50.01)
Female	59,766 (49.99)
Residential area	
Urban	70,971 (59.36)
Rural	48,586 (40.64)

Note: Study participants with missing data were excluded.

years, and 59.3% of the participants were from urban areas. The demographic data of the study population are provided in Table 1.

The prevalence estimate of the low PA in the whole population from 2007 to 2010 was estimated to be 35.8% (95% confidence interval, 34.1–37.6). The results of hot spot analysis showed that Kerman province was a low PA hot region ($P < .05$). Ilam, Kermanshah, Hamedan, and Markazi were low PA cold spots ($P < .05$) (Figure 1A). Razavi Khorasan ($P < .01$), Semnan, Northern Khorasan, and Golestan provinces ($P < .05$) were hot spots for moderate PA level (Figure 1B). Ilam ($P < .01$), and Kermanshah, Hamedan, Markazi, and Kurdistan provinces ($P < .05$) were hot spots for high PA level. Fars province was a cold spot for high PA level ($P < .05$) (Figure 1C). Table 2 presents the levels of PA by gender in Iranian adults aged 15–64 years from 2007 to 2010.

Hot spot analysis showed that in men, Ilam and Khuzestan provinces were hot spots for the TPA volume (MET minutes per week) ($P < .05$). Although the provinces of Kermanshah and Lorestan were hot regions for TPA volume (MET minutes per week), the differences were not statistically significant (Figure 1D).

Figure 1 — Low level of physical activity (A), moderate level of physical activity (B), high level of physical activity (C), hot spot maps for METs in males (D), METs in females (E), and METs in total (F). METs indicate metabolic equivalents.

Table 2 The Levels of Physical Activity by Gender in Iranian Adults Aged 15–64 years, 2007–2010

Province	Levels of physical activity								
	Low % (n)			Moderate % (n)			High % (n)		
	95% confidence interval			95% confidence interval			95% confidence interval		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
East Azerbaijan	24.5 (525) 22.6–26.4	47.9 (972) 41.2–54.7	36.1 (1497) 32.5–39.8	20.1 (407) 16.9–23.5	25.7 (493) 19.8–32.7	22.9 (900) 18.6–27.7	55.4 (1053) 53.9–56.8	26.2 (534) 21.2–31.9	41 (1587) 37.9–44.1
West Azerbaijan	23.6 (517) 21.1–26.3	53.4 (1052) 50.1–56.7	38.3 (1569) 35.5–41.1	22.2 (457) 20.1–24.5	23.24 (464) 21.6–24.9	22.7 (921) 22.1–23.3	54.1 (1025) 51.2–56.9	23.3 (486) 20.9–25.8	38.9 (1511) 36.4–41.4
Ardabil	28.5 (618) 23.9–33.6	49.4 (1003) 40.7–58.1	38.8 (1621) 32.4–45.7	17.7 (380) 14.6–21.4	21.5 (420) 18.5–24.9	19.6 (800) 17.1–22.4	53.6 (999) 46.4–60.7	28.9 (572) 21.1–38.3	41.4 (1571) 34.1–49.3
Esfahan	26.5 (582) 24.5–28.6	50.4 (1017) 44.8–56.1	38.3 (1599) 34.9–41.8	24.3 (492) 18.6–31.1	31.9 (633) 25.8–38.7	28.1 (1125) 22.3–34.6	49.1 (923) 44.5–53.7	17.6 (349) 15.4–20.1	33.5 (1272) 30.3–37.1
Ilam	18.1 (395) 14.7–22.0	36.08 (688) 30.2–42.3	27.1 (1083) 23.7–30.4	18.1 (387) 13.6–23.8	23.1 (463) 19.6–26.9	20.6 (850) 17.2–24.7	63.6 (1212) 55.1–71.4	40.8 (848) 32.1–50.2	52.3 (2060) 45.8–58.8
Bushehr	33.8 (767) 30.3–37.6	58.8 (1175) 54.3–63.1	46.1 (1942) 42.7–49.6	18.7 (377) 17.1–20.4	26.1 (499) 25.2–26.7	22.32 (876) 21.5–23.1	47.43 (855) 43.5–51.3	15.1 (324) 10.8–20.7	31.4 (1179) 28.1–35.1
Tehran	27.7 (626) 23.4–32.4	43.4 (890) 37.4–49.7	35.5 (1516) 30.5–40.8	25.2 (528) 24.1–26.4	35.5 (696) 33.1–37.9	30.3 (1224) 28.7–31.9	47.1 (841) 42.2–51.8	21.1 (410) 16.4–26.5	34.1 (1251) 29.4–39.1
Chaharmahal and Bakhtiari	19.9 (446) 12.9–29.4	40.4 (821) 33.1–48.1	30.1 (1267) 23.1–38.2	14.6 (299) 11.5–18.4	25.1 (460) 22.8–27.4	19.7 (759) 17.2–22.5	65.4 (1273) 53.9–75.3	34.5 (689) 25.5–44.7	50.1 (1962) 40.4–59.8
Razavi Khorasan	21.2 (479) 19.3–23.3	37.9 (763) 33.4–42.6	29.5 (1242) 26.3–32.8	21.7 (453) 20.7–22.7	30.9 (586) 26.5–35.6	26.2 (1039) 24.1–28.6	57.1 (1062) 54.1–59.9	31.1 (638) 24.6–38.2	44.2 (1700) 39.7–48.8
Khuzestan	26.1 (601) 23.4–28.8	55.1 (1110) 49.8–60.1	40.3 (1711) 36.5–44.2	20.5 (419) 18.5–22.8	25.5 (487) 23.6–27.5	23.1 (906) 22.4–23.6	53.3 (941) 48.9–57.7	19.4 (373) 16.1–23.2	36.6 (1314) 32.8–40.5
Zanjan	19.5 (440) 14.1–26.5	41 (811) 36.2–45.9	30.1 (1251) 25.1–35.6	20.3 (410) 17.8–23.1	29.8 (579) 28.1–31.6	25.1 (989) 23.8–26.2	60.1 (1151) 51.9–67.8	29.1 (596) 24.1–34.6	44.8 (1747) 38.5–51.3
Semnan	31.2 (671) 26.7–36.1	48.9 (974) 43.9–53.8	39.9 (1645) 35.3–44.7	18.3 (407) 16.9–19.7	33.3 (656) 31.3–35.4	25.7 (1063) 25.2–26.2	50.4 (917) 45.5–55.4	17.7 (396) 13.9–22.2	34.3 (1286) 29.9–38.9
Sistan and Baluchestan	34.5 (742) 30.9–38.2	61.7 (1210) 57.1–66.1	47.9 (1952) 44.1–51.8	21.2 (435) 17.3–25.7	20.1 (413) 17.1–23.5	20.6 (848) 17.5–24.1	44.2 (785) 36.9–51.8	18.1 (346) 13.3–24.1	31.3 (1131) 25.2–38.1
Fars	32.5 (697) 24.6–41.5	51.1 (978) 38.3–63.8	41.7 (1675) 31.7–52.3	23.3 (465) 20.4–26.4	25.4 (493) 23.2–27.2	24.3 (958) 22.8–25.9	44.1 (805) 33.1–55.7	23.4 (478) 13.4–37.6	33.9 (1283) 23.3–46.3
Qazvin	29.1 (635) 24.4–34.2	49.3 (979) 45.9–52.7	39.1 (1614) 35.1–43.2	20.1 (430) 18.3–21.8	26.9 (543) 24.1–29.9	23.4 (973) 21.2–25.7	50.8 (937) 46.8–54.8	23.7 (472) 21.7–25.8	37.4 (1409) 34.8–40.1
Qom	29.3 (655) 25.5–33.4	54.7 (1123) 46.6–62.6	41.8 (1778) 36.1–47.9	27.7 (545) 24.2–31.5	29.3 (566) 25.7–33.2	28.5 (1111) 26.5–30.6	42.9 (794) 37.2–48.7	15.8 (312) 11.8–21.1	29.5 (1106) 24.9–34.6
Kurdistan	22.1 (469) 18.4–26.2	44.1 (853) 36.1–52.2	32.9 (1322) 27.4–38.9	20.1 (392) 18.4–21.6	21.4 (417) 20.1–22.8	20.7 (809) 19.7–21.7	57.9 (1134) 54.1–61.6	34.4 (727) 27.6–41.9	46.3 (1861) 41.3–51.4
Kerman	26.3 (586) 23.6–29.2	54.6 (1099) 50.3–58.7	40.3 (1685) 38.1–42.5	18.8 (390) 15.6–22.4	22.6 (425) 20.8–24.4	20.6 (815) 19.6–21.7	54.8 (1019) 51.8–57.9	22.7 (469) 20.2–25.5	39.1 (1488) 36.6–41.4
Kermanshah	20.2 (474) 17.1–23.7	43.2 (831) 32.9–54.2	31.6 (1305) 25.5–38.4	24.7 (518) 22.3–27.3	32.1 (664) 29.9–34.3	28.3 (1182) 26.2–30.4	55.1 (1006) 50.4–59.5	24.7 (504) 14.8–38.1	40.1 (1510) 32.4–48.1
Kohgiluyeh and Boyer-Ahmad	15.1 (349) 11.9–18.8	29.7 (625) 23.4–36.8	22.3 (974) 17.6–27.7	21.6 (448) 17.7–26.1	28.6 (548) 21.9–36.3	25.1 (996) 20.6–30.2	63.2 (1198) 57.6–68.5	41.6 (826) 36.8–46.5	52.5 (2024) 48.3–56.7
Golestan	25.7 (589) 22.6–29.1	52.3 (1061) 48.1–56.5	38.8 (1650) 35.6–42.2	17.2 (379) 15.7–18.9	23.8 (450) 22.5–25.2	20.5 (829) 19.3–21.7	56.9 (1029) 53.7–60.1	23.8 (475) 20.4–27.5	40.6 (1504) 38.1–43.1
Gilan	20.6 (441) 15.7–26.6	44.6 (865) 38.1–51.3	32.4 (1306) 26.7–38.7	19.5 (395) 16.7–22.7	27.1 (532) 26.2–27.8	23.2 (927) 21.6–24.9	59.8 (1147) 51.8–67.2	28.3 (593) 22.4–35.1	44.2 (1740) 37.3–51.3
Lurestan	13.2 (295) 12.3–14.1	34.49 (678) 28.4–41.1	23.74 (972) 20.4–27.3	16.06 (345) 13.7–18.6	33.3 (628) 31.4–35.3	24.6 (973) 23.2–26.1	70.7 (1353) 68.6–72.7	32.1 (682) 26.6–38.7	51.6 (2035) 48.7–54.5
Mazandaran	15.5 (351) 13.8–17.4	31.1 (625) 28.8–33.4	23.2 (976) 21.2–24.9	19.4 (400) 16.1–23.2	29.9 (565) 27.5–32.5	24.6 (965) 21.8–27.6	65.1 (1250) 62.1–67.8	38.8 (804) 35.8–41.9	52.1 (2054) 49.2–55.1
Markazi	14.8 (342) 12.7–17.3	45.1 (901) 34.2–56.5	29.8 (1243) 24.1–36.1	20.8 (447) 18.2–23.6	29.2 (578) 23.9–35.1	24.9 (1025) 21.1–29.2	64.3 (1210) 59.7–68.6	25.6 (519) 18.1–35.1	45.2 (1729) 40.1–50.5
Hormozgan	34.5 (756) 29.4–40.1	58.5 (1172) 50.3–66.2	46.4 (1937) 39.9–53.1	22.6 (470) 20.4–25.1	24.7 (497) 21.2–28.6	23.6 (967) 22.4–24.9	42.7 (749) 37.1–48.7	16.7 (341) 12.1–22.7	29.9 (1090) 24.8–35.6

(continued)

Table 2 (continued)

Province	Levels of physical activity								
	Low % (n)			Moderate % (n)			High % (n)		
	95% confidence interval			95% confidence interval			95% confidence interval		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Hamedan	18.7 (420) 14.9–23.3	47.8 (938) 45.1–50.5	33.1 (1358) 29.9–36.4	22.4 (461) 18.8–26.6	31.6 (641) 30.3–32.9	27 (1102) 24.7–29.3	58.7 (1117) 51.1–66.1	20.5 (420) 18.1–23.2	39.8 (1537) 35.2–44.7
Yazd	38.1 (784) 33.2–43.1	57.5 (1151) 53.5–61.4	47.6 (1935) 43.6–51.7	16.9 (351) 14.9–19.1	26.2 (516) 23.5–29.2	21.5 (867) 19.7–23.4	45.1 (865) 41.3–48.8	16.1 (331) 13.5–19.2	30.8 (1196) 27.6–34.2
South Khorasan	22.3 (457) 18.5–26.7	36.4 (723) 31.8–41.4	29.3 (1180) 27.2–31.5	20.4 (428) 19.1–21.8	29.2 (551) 26.2–32.4	24.7 (979) 22.7–26.9	57.1 (1113) 52.9–61.3	34.2 (724) 26.9–42.4	45.8 (1837) 42.2–49.5
North Khorasan	24.1 (516) 19.1–29.6	47.5 (978) 37.9–57.3	35.6 (1494) 28.6–43.2	20.47 (409) 17.7–23.4	27.4 (509) 25.1–29.8	23.9 (918) 22.1–25.8	55.5 (1072) 47.4–63.2	25.1 (513) 16.1–36.8	40.4 (1585) 31.7–49.7

Men's hot spot analysis showed that Ilam province ($P < .01$) and Khuzestan ($P < .05$) were hot spots for TPA volume (MET minutes per week) (Figure 1E). Ilam, Khuzestan, Kermanshah, and Lorestan were hot spots for women, but the differences were not statistically significant than the national average ($P > .05$) (Figure 1F). Table 3 depicts TPA, the average time spent at

Table 3 Total Physical Activity, the Average Time Spent at Work, Commute, Recreation, and Sedentary Behavior, Status by Gender in Iranian Adults Aged 15–64 years, 2007–2010

Province	METs, min/wk		
	Male, median (IQR)	Female, median (IQR)	Total, median (IQR)
East Azerbaijan	3960 (9720)	1080 (3120)	2100 (5920)
West Azerbaijan	4040 (9520)	960 (2720)	1800 (6040)
Ardabil	3420 (8460)	840 (3540)	1920 (5880)
Esfahan	2880 (8760)	780 (1920)	1440 (4680)
Ilam	5160 (8000)	2640 (5360)	3720 (6960)
Bushehr	2720 (6560)	600 (1760)	1320 (4000)
Tehran	2400 (6240)	960 (2080)	1440 (3720)
Chaharmahal and Bakhtiari	6720 (13,680)	1560 (4440)	3200 (8920)
Razavi Khorasan	4400 (10,560)	1440 (3480)	2400 (6620)
Khuzestan	3600 (8760)	720 (2040)	1560 (5180)
Zanjan	4800 (10,720)	1280 (3240)	2280 (6260)
Semnan	3120 (9680)	840 (1880)	1440 (4680)
Sistan and Baluchestan	2640 (7200)	480 (1840)	1140 (4320)
Fars	2520 (7000)	720 (2460)	1440 (4760)
Qazvin	3180 (7440)	840 (2400)	1680 (4640)
Qom	2160 (5280)	660 (1600)	1200 (3480)
Kurdistan	5280 (13,200)	1600 (4320)	2880 (7800)
Kerman	4320 (10,440)	720 (2760)	1840 (6400)
Kermanshah	3360 (5280)	1200 (2600)	1920 (4080)
Kohgiluyeh and Boyer-Ahmad	5160 (9080)	2160 (4640)	3480 (6560)
Golestan	4320 (10,920)	800 (2880)	1800 (6360)
Gilan	4560 (11,680)	1080 (3360)	2280 (6760)
Lurestan	7080 (11760)	1680 (3480)	3360 (7920)
Mazandaran	5760 (11,400)	2040 (4440)	3360 (7160)
Markazi	5520 (11,940)	1080 (2880)	2400 (6720)
Hormozgan	2040 (5760)	560 (1760)	1040 (3640)
Hamedan	4080 (8280)	840 (2100)	1800 (4960)
Yazd	2880 (9880)	560 (1860)	1200 (4800)
South Khorasan	4800 (10,200)	1680 (4080)	2680 (6840)
North Khorasan	4560 (10,080)	960 (3320)	2160 (6480)

Abbreviations: IQR, interquartile range; METs, metabolic equivalents.

work, commute, recreation, and sedentary behavior, status by gender in Iranian adults aged 15–64 years, 2007–2010.

Discussion

The aim of this study was to examine the distribution of PA prevalence across different provinces of Iran using geographic maps of national surveys (2007–2010) to illustrate a geographic pattern of PA levels through GIS mapping. We used hot spot analysis (Getis-Ord Gi*) to better understand that how different types of locations impact on prevalence of the PA in an objective way that does not rely on subjective judgments of the visual patterns.

Iran faces growing prevalence of low PA⁵; recent data suggest that the prevalence of low PA increased by 10% absolute points over 5 years, from 35% in 2006 to 45% in 2011.⁵

The descriptive findings of this study showed that Sistan and Baluchestan, Yazd, and Hormozgan that are located in the south and southeast of Iran consistently reported lower PA rates compared with other provinces. Although there is no clear explanation for this finding, a closer examination of PA pattern in these geographical units could shed light as to whether it is a chance finding or a systematic pattern. The objective hot spot analysis showed significantly low PA in the Kerman province; it is possible that the socioeconomic profile (low level of socioeconomic status) of this area explains this finding.²⁷ This positive association between low socioeconomic status and overall PA level has been reported by other studies previously.²⁶ Some other explanations for these findings relate to weather conditions in this region, which includes very high temperature and desert climate. Such conditions may discourage people to move without a vehicle while sports facilities (eg, sports fields and swimming pools) supply does not correspond with demand. Moreover, as few people farm or grow livestock and due to climatic conditions, activity may be reduced.

The other key finding is that geographical PA distribution has a particular pattern, as cold and mountainous areas such as north and northwest provinces, such as Ilam, Lorestan, and Mazandaran, mainly located along Alborz and Zagros Mountains range represent a higher level of PA. The hot spot analyses' findings illustrate Ilam as a hot region for high level of PA. A possible explanation for these results is that people in this area working with livestock and agriculture; the low prevalence of diabetes in this area supports this interpretation.²⁵ Moreover, in mountainous areas in Iran, car use is infrequent, and incidental PA for transportation is bound to be higher. In the northern parts across the coastline, people may walk more and may be doing more swimming in the sea. Defining PA levels by geographic locations may produce a basis for supporting a better distribution of national resources for PA promotion as well as helping to shape effective health care.

Geographic information systems played a critical role in data analysis in our study by patterning the geographical variations in PA. If a higher resolution of participants' location such as town and small cities was available, more advanced spatial analysis such as smoothing or spatial regression analyses would be possible. However, the national survey data only provided a provincial level of living address; through this, GIS was used to display geographical variation at the PA levels. Although GIS enables to easily connect between health matters and geographic information, spatial analysis using GIS technologies assists investigating the association of PA and neighborhood, or local environment that can build a "PA-friendly" society including parks, recreational amenities, and road network such as a sidewalk, traces, and bike paths.

This GIS feature can be relevant to other health issues related to PA, such as obesity or chronic diseases.^{9,24}

Physical inactivity is a serious public health issue in Iran, and measures to tackle it are needed. Despite the substantial progress made with developing national various PA policy documents in recent years,^{28,29} physical inactivity is still a low political priority in Iran, and there is not a national strategy.²⁸ Without political commitment to a long-term national PA strategy covering both structured exercise and incidental PA (eg, active commuting), it is unlikely that the inactivity epidemic can be reversed. Increasing PA levels in the adult population will only be possible by developing and implementing a mixture of different interventions that are tailored to the geographical, climatic, and socioeconomic profile of a large country like Iran. Our data revealed consistent geographical patterns that can inform such interventions.

Strengths and Limitations

Strengths include the large nationally representative sample and use of the GPAQ, which allowed a comprehensive account of PA and the geographic analytical maps. To our knowledge, no such work has been previously conducted in Iran. Data were collected by trained professionals using consistent methods, and there was no need to employee retrospective harmonization. Our results must be interpreted in the context of the study limitations, which include the self-reported nature of the PA data that are subject to recall and social desirability bias.

Conclusions

This is the first detailed analysis of geographical patterning of PA prevalence in Iran using geographic maps. This study used GIS to serve in a visualization of PA status in different geographic locations; we identified large variation in PA across Iran provinces. The regions with low PA are predominately situated in the southeast and near to the center of Iran; conversely, high PA regions are mainly located in the west. These findings may enhance public awareness of the regional variations in PA and provide a basis for developing evidence-based health policies for vulnerable populations. In terms of linking PA data with regional-built environmental resources further utilizes that GIS should be implemented by future studies.

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