Area-level socioeconomic disparity trends in nutritional status among 5–6-year-old children in Israel

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ABSTRACT

Objective This study aimed to assess area-level socioeconomic position (SEP) disparities in nutritional status, to determine whether disparities differed by sex and to assess whether nutritional status and disparities changed over time.

Design We used repeated cross-sectional data from a national programme that evaluates the quality of healthcare in Israel to assess children's nutritional status.

Setting The study included all Israeli residents aged 7 years during 2014–2018 (n=699 255).

Methods SEP was measured based on the Central Bureau of Statistics' statistical areas, and grouped into categories, ranging from 1 (lowest) to 10 (highest). We used multivariable multinomial regression to assess the association between SEP and nutritional status and between year and nutritional status. We included interactions between year and SEP to assess whether disparities changed over time.

Results Children in SEP 1, comprised entirely of children from the Bedouin population from Southern Israel, had drastically higher odds of thinness compared with those in the highest SEP (Girls: OR 5.02, 99% CI 2.23 to 11.30; Boys: OR 2.03, 99% CI 1.19 to 3.48). Odds of obesity were highest in lower-middle SEPs ($OR_{SEP\ 5\ vs\ 10}$ 1.84, 99% CI 1.34 to 2.54). Prevalence of overweight and obesity decreased between 2014 and 2018, normal weight increased and thinness did not change. SEP disparities in thinness decreased over time in boys but showed a reverse trend for girls. No substantial improvement was seen in SEP disparities for other weight categories.

Conclusions Our study demonstrates the need to consider initiatives to combat the considerable SEP disparities in both thinness and obesity.

What is already known on this topic?

- Individual-level socioeconomic position is inversely associated with childhood obesity in high-income countries.
- Mixed results have been found when assessing the association between individual level socioeconomic position and thinness.
- Mixed results have also been found when assessing the impact of area-level socioeconomic position on childhood bodymass index.

What this study adds?

- Overweight and obesity prevalence rates decreased over time, normal weight increased and no change was found for thinness prevalence.
- Major disparities in childhood thinness were found using area-level measures of socioeconomic position, with highest thinness rates found for children in the lowest socioeconomic position.
- Substantial disparities were observed in obesity rates, with highest obesity rates found for children in the lower-middle socioeconomic positions. These disparities did not improve over time.

INTRODUCTION

Childhood overweight and obesity (ie, high body mass index (BMI) for age and sex) are associated with adverse life-course health.[1 2] Childhood thinness (ie, low BMI for age and sex) also imposes substantial consequences for child development including stunting, a weakened immune system and disability later in life.[3 4]

Early childhood is a critical period for detecting children at risk of overweight, obesity and undernutrition. School-aged children with obesity are 6.5 times more likely to become adults with obesity compared with children without obesity,[5] while children with persistently low BMI through infancy, who have a rapid BMI increase in later childhood, have a 30% higher risk of developing type 2 diabetes mellitus in adulthood.[6]

Individual-level socioeconomic position (SEP) is inversely associated with obesity across high-income countries.[7] Few studies in high-income countries have assessed the association between SEP and thinness, and these have found mixed results.[8 9] Conflicting results have also been found regarding the association between area-level SEP and childhood BMI.[10–12]

Between-country comparisons of children's nutritional status is challenging due to the use of several definitions and reference cut-off points (Centers for Disease Control and Prevention, WHO and International Obesity Task Force growth references) and different terms (underweight, wasting, thinness, undernutrition).[13] In this paper, we have used the

terms thinness, overweight and obesity using the WHO reference population.[14]

Our study aimed to assess the prevalence of thinness, normal weight, overweight and obesity among Israeli children, to assess area-based SEP disparities in nutritional status and to determine whether these disparities differed by sex. In addition, we aimed to assess trends in nutritional status over time and to examine whether SEP disparities differed over time.

METHODS

The Israel Quality Indicators in Community Healthcare (QICH) programme is a national programme that monitors and evaluates the quality of community-based healthcare provided through Israel's four health maintenance organisations (HMOs) using data originating from electronic medical records, for the entire Israeli population.[15] Our study used QICH data to assess the nutritional status of Israeli children.

Population

The study population included all children aged 7 years in 2014–2018 (data included distinct cohorts of children aged 7 for every given year). In 2014–2015, the population was limited to three of the four HMOs, covering 92% of the children's population in that period. From 2016, data were available from all four HMOs, covering all children who were residents of Israel. The data do not include children with incomplete membership in an HMO during the study period (<2% of the population).[15] Finally, we excluded children with a missing SEP from our analysis (n=29 719). A total of 699 255 children were included in the study.

Data

For the current study, we used quality indicators from the QICH programme, regarding childhood nutritional status. All the indicators in the QICH programme are calculated by the HMOs, using individual-level information, and then anonymised and aggregated before they are shared with the QICH programme. Weight and height are routinely measured in children aged 5–6 in all Israeli HMOs; measurements are taken and recorded by trained staff using a published protocol of the Israeli Ministry of Health.[16] The HMOs calculated the proportion of children aged 7 years with documentation of at least one measurement of height and weight during the past 2 years (when the children were ages 5–6). For children with more than one height and weight measurement available during the relevant time period, the most recent height and weight measurements were used to determine their BMI(weight in kilograms divided by the square of the child's height in metres). Nutritional status was determined by the HMO using WHO growth standards to classify sex-age-specific BMI z-scores for each child, using the child's sex and exact age. BMI z-scores and cut-off values were calculated using WHO guidelines.[17] Data were calculated individually and transferred to QICH aggregated by age, sex and BMI z-score category. Four BMI categories were used: thinness (BMI z-score <–2 SD), normal weight (BMI z-score ≥2 SD and <+1 SD), overweight (BMI z-score ≥+1 SD and <+2 SD), obesity (BMI z-score ≥+2 SD).

Socioeconomic position (SEP)

SEP was based on the small statistical areas (SSA) used in the 2008 Israeli census. SSAs contain 3000–4000 people and are created in a way that maintains homogeneity in terms of the sociodemographic makeup of the population.[18] The Central Bureau of Statistics (CBS) used information regarding demography, education, employment, housing conditions and household income to define the SSAs, and these were grouped into 20 categories.[18] As the latest data available from the CBS was from 2008, we used data updated by the POINTS Location Intelligence Company to improve the accuracy of the SEP measure, using current sociodemographic, commercial and housing data.[19] These data were grouped into 10 categories, ranging from 1 (lowest) to 10 (highest). SEPs 1–2 (the lowest SEPs) consist predominantly of Arab neighbourhoods, with SEP 1 consisting exclusively of the Bedouin population of Southern Israel. SEPs 6–10 are predominantly Jewish, while SEPs 3–5 consist of a mix of Jewish and Arab neighbourhoods (Personal communication with POINTS Location Intelligence Company).

Statistical analysis

We report findings of nutritional status using proportions, by sex and SEP for the most recent year (2018) and nutritional status prevalence for every year available. As our outcome of interest was categorical, we used multivariable multinomial regression models, adjusted for sex, to assess the association between SEP and nutritional status for every year from 2014 to 2018. Normal weight was used as the reference category.

We first assessed whether the trend of the association between SEP and nutritional status was monotonic. If monotonic, we compared the most extreme SEP groups.[20] We found a monotonic trend for thinness and overweight, and we therefore compared the lowest and highest SEPs (1 vs 10) to assess SEP disparities in these categories. In obesity, instead of a monotonic trend, we found a reverse U-shaped association and therefore included a quadratic term for SEP to the model. Goodness of fit of the quadratic model was assessed using a likelihood ratio test. To assess SEP disparities in this category, we compared the lower-middle SEP to the highest (5 vs 10), as SEP 5 consistently had the highest prevalence of obesity.

In order to assess whether the association between SEP and nutritional status differed by sex, we included an interaction between sex and SEP. As we found a significant interaction between sex and SEP, we presented results stratified by sex.

We used a logistic regression model, adjusted for SEP and sex, to assess whether the prevalence of nutritional status changed over time, allowing us to assess the trend for thinness, normal weight, overweight and obesity separately (multinomial model showed similar trends). We used a multivariable multinomial regression model, including an interaction between year (as a continuous variable) and SEP, to assess whether SEP disparities differed over time.

Due to the large sample size, we based statistical significance on a p value of 0.01 and reported 99% CIs. Analyses were performed using Stata V.14.0 (Stata, College Station, Texas, USA).

Ethical standards

The manuscript does not contain clinical studies or patient data.

RESULTS

Documentation of height and weight among 5–6 years old preschoolers was high overall, and ranged from 70.4% to 92.4% in boys, and from 71.2% to 91.2% in girls in 2018 (data not shown). The documentation rate in the lowest SEP was 91.8%, while the documentation rate for children in the highest SEP was 70.8%. Overall, documentation was available for 78.6% of the 148 540 children in 2018, yielding 116 774 children. A total of 546 848 children were included for 2014–2018. SEP was not

Table 1 Nutritional status of Israeli children aged 5–6 in 2018, by socioeconomic position and sex (n=116 774)

	Total		Thinness		Normal weight		Overweight		Obesity	
	N	%	N	Rate (%)	N	Rate (%)	N	Rate (%)	N	Rate (%)
Total	116 774		4986	4.3	90 451	77.4	13 206	11.3	8131	7.0
SEP										
1	4465	3.8	353	7.9	3540	79.2	356	8.0	216	4.8
2	9803	8.4	589	6.0	7728	78.8	940	9.6	546	5.6
3	17 776	15.2	1025	5.8	13 614	76.6	1913	10.8	1224	6.9
4	15 302	13.1	644	4.2	11 690	76.3	1796	11.7	1172	7.7
5	17 719	15.2	687	3.9	13 308	75.1	2157	12.2%	1567	8.8
6	19 291	16.5	687	3.6	14 885	77.1	2304	11.9%	1415	7.3
7	15 769	13.5	503	3.2	12 382	78.5	1805	11.4%	1079	6.8
8	9506	8.1	278	2.9	7569	79.6	1107	11.6	552	5.8
9	5743	4.9	181	3.2	4610	80.3	664	11.6	288	5.0
10	1400	1.2	39	2.8	1125	80.4	164	11.7	72	5.1
Girls	56 678		2082	3.7	44 201	78.0	6674	11.8	3721	6.6
SEP										
1	2224	3.9	173	7.8	1769	79.5	178	8.0	104	4.7
2	4698	8.3	277	5.9	3734	79.4	453	9.6	234	5.0
3	8710	15.4	436	5.0	6781	77.8	963	11.1	530	6.1
4	7308	12.9	265	3.6	5635	77.1	894	12.2	514	7.0
5	8666	15.3	280	3.2	6537	75.4	1099	12.7	750	8.7
6	9421	16.6	273	2.9	7307	77.5	1183	12.6	658	7.0
7	7661	13.5	195	2.5	6015	78.5	924	12.1	527	6.9
8	4556	8.0	107	2.3	3644	79.9	562	12.3	243	5.3
9	2747	4.8	65	2.4	2214	80.6	341	12.4	127	4.6
10	687	1.2	11	1.6	565	82.2	77	11.2	34	4.9
Boys	60 096		2904	4.8	46 250	76.9	6532	10.9	4410	7.3
SEP										
1	2241	3.7	180	8.0	1771	79.0	178	7.9	112	5.0
2	5105	8.5	312	6.1	3994	78.2	487	9.5	312	6.1
3	9066	15.1	589	6.5	6833	75.3	950	10.5	694	7.7
4	7994	13.3	379	4.7	6055	75.7	902	11.3	658	8.2
5	9053	15.1	407	4.5	6771	74.8	1058	11.7	817	9.0
6	9870	16.4	414	4.2	7578	76.8	1121	11.4	757	7.7
7	8108	13.5	308	3.8	6367	78.5	881	10.9	552	6.8
8	4950	8.2	171	3.5	3925	79.2	545	11.0	309	6.2
9	2996	5.0	116	3.9	2396	80.0	323	10.8	161	5.4
10	713	1.2	28	3.9	560	78.5	87	12.2	38	5.3

SEP, socioeconomic position.

uniformly distributed; 3.8% of children were in the lowest SEP (SEP 1), 1.2% of children were in the highest SEP (SEP 10) and 74% of children were in SEPs 3–7 (table 1).

In 2018, 4.3% of children were documented as being thin (table 1). Thinness was more common in boys compared with girls (4.8% vs 3.7%) (p<0.001). Thinness rates decreased monotonically as SEP increased (table 1 and figure 1A). Prevalence of normal weight decreased between SEP 1 and SEP 5 and then showed an increasing trend (table 1 and figure 1B). Overweight prevalence was slightly higher in girls compared with boys (11.8% vs 10.9%) (p<0.001). Overweight rates increased between SEP 1 and SEP 5 and then remained relatively stable (table 1 and figure 1C). Obesity prevalence was slightly lower in girls compared with boys (6.6% vs 7.3%) (p<0.001). Obesity rates were highest in SEP 5 (girls 8.7%, boys 9.0%) and lowest in SEPs 1 and 10 (table 1 and figure 1D).

Focusing on the most recent year available (2018), we found considerable disparities in the rate of thinness (Lowest vs Highest SEP: Girls: OR 5.02, 99% CI 2.23 to 11.30; Boys: OR 2.03, 99% CI 1.19 to 3.48) (table 2). The association between SEP and overweight did not differ substantially between girls and boys (p=0.78). Boys and girls in SEP 1 had lower odds of being overweight compared with those in SEP 10, although this association was only statistically significant in boys (Girls: OR 0.74, 99% CI 0.51 to 1.07, Boys: OR 0.65, 99% CI 0.45 to 0.93). The association between SEP and obesity was not linear, and the addition of a quadratic term significantly improved the goodness-of-fit of the model assessing the association between SEP and obesity, indicating an inverse U-shaped association. The odds of obesity in SEP 5 were nearly two times the odds of obesity in the highest SEP (Girls: $OR_{SEP\ 5\ vs\ 10}$ 1.91, 99% CI 1.20 to 3.04; Boys: $OR_{SEP\ 5\ vs\ 10}$ 1.78, 99% CI 1.14 to 2.77).

The prevalence of thinness did not change over time (p=0.53) (online supplementary figure 1). We detected an increasing trend in normal weight (74.5% in 2014 vs 77.4% in 2018, p<0.001), while the prevalence of overweight and obesity decreased over time (Overweight: 13.3% to 11.3%; p<0.001, Obesity: 8.0% to 7.0%; p<0.001).

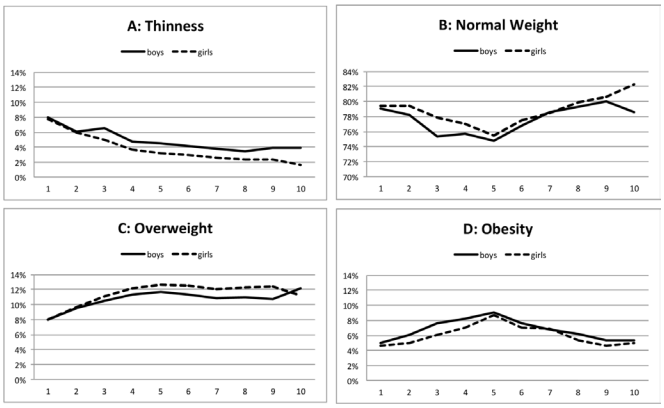

Figure 1 Nutritional status of 5–6-year-old boys and girls, by SEP, 2018, Israel (n=116 774). (A) Thinness among boys and girls. (B) Normal weight among boys and girls. (C) Overweight among boys and girls. (D) Obesity among boys and girls. SEP, socioeconomic position.

SEP disparities in thinness increased for the first few years, followed by a decrease (p=0.004) (table 2). Although the change in disparities was not monotonic, among boys, the disparities were reduced from 3.4 in 2014 to 2.0 in 2018, while a reverse trend was seen in girls (2.7 in 2014, 5.0 in 2018). We found a weak trend in disparities for overweight, in boys and girls, and the disparities were not significant for most of the years we assessed. SEP disparities in obesity fluctuated over time in both girls and boys. Among girls, the disparities increased from 1.5 in 2014 to 1.9 in 2018, while in boys, the disparities in 2014 were very similar to those in 2018 (1.8 and 1.7, respectively).

DISCUSSION

Overweight and obesity prevalence rates decreased over time, while the prevalence of normal weight increased, with no change in thinness prevalence. Major SEP disparities were observed for thinness as well as for obesity. Over the 2014–2018 period, SEP disparities in thinness decreased for boys, but increased for girls. Disparities in overweight did not change over time. SEP disparities in obesity worsened slightly for girls and did not change for boys.

We found major disparities in thinness prevalence between the lowest SEP and all other SEPs. SEP 1 in our study is comprised entirely of the minority Bedouin population, which differs from other groups in Israeli society in terms of cultural norms, SEP and health-related behaviours and outcomes. The Bedouins living in Israel are a previously nomadic people, who have undergone a transition over the past 50 years. Notably, under the National Health Insurance law, the Bedouin population is covered by mandatory health insurance and has access to healthcare.[21] Nearly 40% of Bedouins live in unrecognised villages, in which living conditions are especially poor.[2] Bedouin children have higher rates of anaemia and longer hospitalisation periods for infectious diseases,[2 22] but have higher rates of timely childhood vaccination[23] and higher rates of height and weight documentation compared with the Jewish population. More generally, health utilisation patterns in Israel differ by SEP, with those in lower SEPs being more likely to see a primary care provider.[24] A previous study among Bedouin children at 18 months of age found that although the rate of stunting decreased substantially between 1990 and 2010, it remained higher than the rate in the Jewish population.[25] Bedouin children in Israel may experience a nutrition transition leading to the double burden of undernutrition and obesity at the same time, as has been found in children in various middle-income and low-income countries and ethnic minorities.[26 27]

Most studies have found an inverse association between individual-level SEP and obesity in high-income countries;[7 28] however, this association varies by gender, age and ethnicity.[29 30] Both positive and negative associations have been reported for the association between area-level SEP and obesity, while others have found no association.[10–12 31] One US study found that while individual-level SEP was consistently inversely associated with

Table 2 Trends in socioeconomic disparities in nutritional status of Israeli children aged 5–6 years with documented height and weight, by measurement year (2014–2018) (n=547 848)

	2014 (n=96 405)	2015 (n=101 575)	2016 (n=115 157)	2017 (n=117 937)	2018 (n=116 774)	P_{Trend}
Total						
Thinness $OR_{SEP\ 1\ vs\ SEP\ 10}$	3.06 (1.97 to 4.76)	3.27 (2.05 to 5.20)	3.62 (2.38 to 5.49)	3.43 (2.27 to 5.21)	2.89 (1.85 to 4.50)	**0.004**
Normal weight OR	Ref	Ref	Ref	Ref	Ref	
Overweight $OR_{SEP\ 1\ vs\ SEP\ 10}$	0.84 (0.63 to 1.12)	0.79 (0.60 to 1.04)	0.99 (0.78 to 1.25)	0.78 (0.60 to 1.01)	0.69 (0.53 to 0.89)	**<0.001**
Obesity OR* $_{SEP\ 5\ vs\ SEP\ 10}$	1.66 (1.22 to 2.27)	1.74 (1.27 to 2.38)	1.62 (1.21 to 2.16)	1.53 (1.13 to 2.07)	1.84 (1.34 to 2.54)	**<0.001**
Girls						
Thinness $OR_{SEP\ 1\ vs\ SEP\ 10}$	2.67 (1.38 to 5.14)	1.94 (1.08 to 3.48)	2.80 (1.58 to 4.95)	4.34 (2.24 to 8.40)	5.02 (2.23 to 11.30)	0.02
Normal Weight OR	Ref	Ref	Ref	Ref	Ref	
Overweight $OR_{SEP\ 1\ vs\ SEP\ 10}$	0.63 (0.42 to 0.94)	0.80 (0.54 to 1.19)	0.74 (0.53 to 1.05)	0.77 (0.52 to 1.16)	0.74 (0.51 to 1.07)	0.01
Obesity $OR_{SEP\ 5\ vs\ SEP\ 10}$	1.50 (0.97 to 2.34)	2.00 (1.21 to 3.31)	1.51 (0.98 to 2.33)	1.54 (0.98 to 2.42)	1.91 (1.20 to 3.04)	**<0.001**
Boys						
Thinness $OR_{SEP\ 1\ vs\ SEP\ 10}$	3.44 (1.90 to 6.23)	6.10 (2.78 to 13.41)	4.62 (2.51 to 8.52)	2.86 (1.67 to 4.90)	2.03 (1.19 to 3.48)	**<0.001**
Normal weight OR	Ref	Ref	Ref	Ref	Ref	
Overweight $OR_{SEP\ 1\ vs\ SEP\ 10}$	1.11 (0.74 to 1.67)	0.80 (0.55 to 1.16)	1.27 (0.91 to 1.77)	0.78 (0.55 to 1.10)	0.65 (0.45 to 0.93)	0.01
Obesity $OR_{SEP\ 5\ vs\ SEP\ 10}$	1.82 (1.19 to 2.80)	1.58 (1.05 to 2.36)	1.71 (1.16 to 2.52)	1.51 (1.00 to 2.27)	1.78 (1.14 to 2.77)	0.01

Multinomial regression models used to assess the association between SEP and nutritional status, adjusted for sex. Multinomial model compared odds of thinness, overweight and obesity to normal weight.
P_{trend} based on multinomial model with an interaction between SEP and time.
Values in bold indicate statistical significance (p<0.01)
*In obesity, instead of a monotonic trend, we found a reverse U-shaped association. To assess SEP disparities in this category, we compared the lower-middle SEP to the highest (5 vs 10), as SEP 5 consistently had the highest prevalence of obesity.
SEP, socioeconomic position.

obesity, substantial geographic differences existed when using an area-level SEP measure.[32] Several recent studies from Australia found large SEP disparities in obesity between children in low SEP versus children in high SEP.[30 33] Higher prevalence of obesity was recently reported among Australian Indigenous children. Similarly, in the UK, the rates of obesity are highest among children in the lowest SEP and not in middle-lower SEPs.[34] Some geographic areas displayed an inverse quadratic association,[32] with highest obesity rates in the lower-middle SEPs, similar to our findings.

Our findings support the stabilisation in obesity prevalence rates found in European countries[7] and even show a small decrease, similar to that found in the Iberian region.[35] This reduction may be due to ongoing efforts of the Israeli ministries of health, education and culture and sports to combat obesity and sedentary lifestyles, with a national programme for active and healthy living.[36] Our study did not find a decreasing trend in thinness, despite a reduction in the global age-standardised prevalence of thinness in both girls and boys.[9]

We did not find a reduction in SEP disparities in overweight and obesity prevalence and even found some increases. Changes in SEP disparities, particularly for thinness, may be influenced by the small number of children in the extreme SEP categories. Increases in SEP disparities have also been found in England,[34] while no change in disparities were found in the US or France.[37 38]

Our study included all children aged 5–6 in Israel and therefore our study was not prone to selection biases or sampling errors. To our knowledge, this is one of the first population studies to include detailed area-level SEP categories. The quality of our data was exceptionally high. Data were checked at three levels: an internal audit by each HMO, a QICH programme directorate data audit and an external process audit.[15]

However, weight and height measurements, which require human assessment and documentation, vary between testers and may be subject to dishonest reporting. In addition, we only had data from the last 5 years and therefore we were unable to assess trends over a longer period.

Children in lower SEPs may not be reaping the greatest benefit from national obesity-prevention efforts and healthy nutrition programmes operated by local HMOs and NGOs operating in Israel. Efforts are necessary to further develop multisectoral sustainable partnerships to enable healthy nutrition for children of low and middle-low SEP.

Correction notice This article has been updated since it was published online. An acknowledgement has been added.

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Contributors YLW and OM conceived and designed the study. VKS, YWS, MK and WAA collected the data. YLW, VKS, YWS, MK, WAA and OM contributed data or analysis tools. YLW performed the analysis. YLW wrote the paper, with considerate input from VKS, YWS, MK, WAA and OM.

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