The Relationship Between Obesity and Blood Pressure Differs by Ethnicity in Sydney School Children

Liang Ke1, Kaye E. Brock2, Rosemary V. Cant2, Yang Li2 and Stephen L. Morrell3

BACKGROUND
The objective of this study was to investigate the relationship between obesity and high systolic blood pressure (SBP) in Southeast Asian (SEAsian) and Australian children living in Australia.

METHODS
SBP, country of birth, and obesity indices (body mass index (BMI), waist circumference (WC), and percent body fat (%TBF)) were recorded in 1,232 9-year-old children from Sydney schools and remeasured 3 years later (n = 628). The relationship between SBP and obesity (both at baseline and longitudinally) was investigated by regression analyses.

RESULTS
Children of SEAsian origin had a significantly higher risk of high SBP with increases in obesity indices compared to those of Australian origin. At 9 years old, SBP increased 1.51 mm Hg for each of BMI increase for SEAsian children compared to 1.05 mm Hg for Australian children (Pinteraction = 0.03). These same significant analysis of variance (ANOVA) interactions were seen with WC (Pinteraction = 0.02) and %TBF (Pinteraction = 0.04) as predictors of SBP. These differences by ethnic background were also reflected in the 3-year longitudinal analysis where SEAsian children showed higher risk of increasing SBP with BMI increase (SBP increased 1.70 mm Hg for each unit of BMI increase for SEAsian children compared to 0.80 mm Hg for Australian children (Pinteraction = 0.02)) or with WC increase (Pinteraction = 0.01), whereas these increases were small and nonsignificant in Australian children.

CONCLUSION
These findings suggest that SEAsian children living in Australia are at higher risk of increasing SBP than their Australian counterparts when they become overweight or obese.


The childhood obesity epidemic has now spread from developed to developing countries.1–7 This epidemic is associated with an increase in hypertension rates which could lead to atherosclerotic disease in adulthood.8–12 Developed countries have attracted significant migrant populations over the past decades, with Australian immigration particularly sourced from Southeast Asian (SEAsian) countries (27% in urban areas).13 The health status of such migrant groups is important to monitor in light of changes to behaviors and cultural norms transposed to newer social and physical environments as migrant children often follow dietary and exercise patterns that are quite different from local children. These patterns result from norms originally formed in their home culture but now applied and adapted to a different setting.14 We took the opportunity to consider the associations between measured obesity status and systolic blood pressure (SBP) in SEAsian children resident in Sydney Australia and how this association might differ from children from nonmigrant backgrounds.

METHODS
Study participants. In 1994, three resting blood pressure (BP) readings were taken in succession in 8–9-year-old children (n = 1,232) randomly sampled from 75 inner city Sydney primary schools.15 The same children were remeasured 3 years later (n = 628).

Procedures. Ethnicity was defined by the country of birth of the children themselves or of the parent (where at least one of their parents was born outside Australia). In this article “Australian” will be defined as children as well as both their parents who were born in Australia (the majority of these being Anglo Celtic); similarly, “SEAsian” will be defined as children who either were born in Southeast Asia or had at least one parent born in Southeast Asia.15 The socioeconomic status (SES) of the child was based on residential postcode, from which area-based (aggregate) SES markers (general index of deprivation) were derived by the Australian Bureau of Statistics from the population census.16 BP readings were recorded by a Dynamap Vital Signs Monitor 8100 BP measuring machine. Three serial BP measurements were taken from the right arm of each child at 30-s intervals. The mean of the second and third readings for BP...
was taken as the main BP outcome measure. We have defined high SBP as that which exceeds the mean SBP + s.d. which is equivalent in our data to greater than the 90th percentile; the definition of hypertension in "Report of the Second Task Force on Blood Pressure Control in Children-1987".17 This is also the definition used in a comparable US hypertension study of 9–12-year-old children.18 It should be noted that in an update published in 199619 high-normal BP is defined as greater than the 90th percentile and less than the 95th percentile, and hypertension defined as greater than the 95th percentile. We have not used this definition as we believe this cutoff may not be appropriate for SEAsian children (only 28 children met these criteria in this study). For the BP measurements, children were seated for ~10 min before the three readings were taken. The mean of the second and third of these BP readings was used to both minimize variability and any "whitecoat hypertension" effects that may have accompanied the first BP reading. As BP was measured under similar conditions and known confounders of the study factors of interest accounted for, it would be expected that this measure of resting BP used was reasonably reliable.20

Anthropometric measurements. Children's heights were measured with socks using a Harpenden pocket stadiometer accurate to ±1 mm. Weights were measured using a Tanita System 502 digital bathroom scale accurate to ±100 g. Body mass index (BMI) was calculated as weight (kg)/height (m²). Age, sex, and ethnic-specific overweight and obesity status was defined according to Cole et al.21 by tracking back to childhood from ethno-specific definitions of adult overweight and obesity. Overweight for 9- and 12-year-old Australian (both boys and girls) was defined as BMI >19 and >21 kg/m², and obesity as BMI >23 and >25 kg/m². Overweight for 9- and 12-year-old SEAsian (both boys and girls) was defined as BMI >17.6 and >19.3 kg/m² and obesity BMI >21 and >23 kg/m². Waist circumference (WC) was measured at the smallest circumference between the ribs and the iliac crest. High WC was defined as greater than the 90th percentile.22 Percent body fat (%TBF) was calculated from a total of biceps, triceps, and subscapular skin-fold thicknesses, measured by a Harpenden Skin-fold caliper23 using the formula %TBF = −22.4 + 15.5 × In (triceps + biceps + subscapular) − 0.09 × height.24 High %TBF was also defined as greater than the 90th percentile in a similar fashion to WC and BMI. Children's physical activity (PA) was recorded twice; either reported as playing actively during lunch or recess breaks in school time or reported as participating in organized sport outside of school hours.15

Longitudinal anthropometric (BMI, WC, and %TBF) and SBP changes were modeled from baseline to follow-up after controlling for confounders and baseline obesity measures. Within-subject changes in SBP were defined as above and below the median, i.e., 7.5 mm Hg. Confounders were SES, PA, birth weight (BW), age and baseline measurements of each anthropometric predictor of interest (i.e., BMI, WC, %TBF).

Statistical analyses. Descriptive statistics and inferential statistical analyses (Pearson's correlation, χ², linear and binary logistic regression, t-test, and analysis of variance (ANOVA)) were performed using the Statistical Package for the Social Sciences (SPSS version 12; SPSS, Chicago, IL). Interactions between relevant covariates were tested by entering the main effect of obesity-related indices (BMI, WC, %TBF) one at a time along with a variable indicating ethnic group (ETH: SEAsian vs. Australian) along with the interaction variable (BMI × ETH) along with confounding variables. SBP was the dependent variable. The P value for interaction was reported as Pinteraction. To test consistency and sensitivity, SBP was tested as both a continuous and categorical outcome and obesity-related variables were either continuous (linear regression) or categorical (ANOVA).

Multivariate modeling was conducted with SBP as the outcome and obesity measures as the independent variables (BMI, WC, %TBF) in linear and logistic models stratified by the ethnicity variable, ETH. To obtain a prediction of the strongest obesity index (by gender) with respect to SBP, step-wise elimination regression models were investigated. When appropriate, risk estimates were presented as odds ratios (ORs) with 95% confidence intervals (95% CI) based on the logistic regression model.25

Ethical approval. Human Ethics Committee approvals were obtained from both Sydney University and the New South Wales Central Sydney Area Health Service.15 Individual consent was gained from the parents of participating children. Consent was active, i.e., only those children whose parents had signed and returned the consent form to the school were measured.15

RESULTS

Population characteristics

Nine-year-old children (n = 1,232) were sampled from 75 inner city Sydney primary schools.15 The same children were remeasured 3 years later (n = 628). Eighty percent of this population consisted of four major ethnic groups Australian-born (31%), European (20%), Middle Eastern (11%), and SEAsian (18%). To test our hypothesis of differences by ethnicity in the association between obesity status and SBP, we investigated these parameters in SEAsian and Australian children. The study participation rate was 40% of eligible children, and after 3 years the follow-up rate was 51%. Children not participating in follow-up had a similar ethnicity and hypertension distribution, but had significantly lower SES status, and participated less in PA outside school and were higher in all measured obesity indices compared to the follow-up respondents (Supplementary Table S1 online).

Demographic, anthropometric, and exercise patterns

Baseline characteristics (Table 1) indicate that obese SEAsian and Australian children were similar in terms of gender, mean DBP, and at-school PA, but the SEAsian children had higher mean SBP, WC, and %TBF despite significantly lower SES,
outside school PA, and mean BW. Thus age, SES, PA, and BW were included as confounders in further statistical comparisons. Australian children were four times more likely than SEAsian children to participate in PA outside of school (OR = 4.5, 95% CI: 3.23–6.54). Interestingly, for the Australian children participation in PA outside school was associated with significantly lower mean BMI but not SBP, whereas in the SEAsian group lower SBP but not BMI was associated with outside school PA. Similar associations to these were also observed for the children aged 12 years at follow-up (data not shown).

**BW and SBP**

A significant negative association between BW and SBP (adjusting for SES, height, and age) has been reported previously in this total population of children. When stratified by ethnicity this association was only observed in children of Australian origin ($r = −0.14, P = 0.002$) not in SEAsian children, despite their higher BW.

**Obesity and SBP prevalence**

When overweight/obese children were investigated by gender, SEAsian children had higher SBP and BMI than Australian children when measured by prevalence of hypertension and overweight (a categorical measure) (Figure 1). At both baseline and follow-up SEAsian children were more likely to be hypertensive or be overweight/obese than Australian children. SEAsian children were twice as likely as Australian children to have a high SBP compared to Australian children at 12 years of age (OR = 1.8, 95% CI: 1.05–3.12), and they were twice as likely to have a high %TBF compared to Australian children at 9 years of age (OR = 1.9, 95% CI: 1.14–3.57), although the former result is only marginally statistically significant.

**Relationship between SBP and obesity indices**

The relationship between SBP and obesity measures was investigated by linear regression (Table 2). As expected, all anthropometric measures were strongly and significantly correlated with SBP but these correlations were consistently higher in SEAsian for all the obesity-related indices examined. SBP increased by 1.51 mm Hg for each unit increase in BMI for SEAsian children compared to 1.05 mm Hg for Australian children. These SBP trends were also observed when WC and %TBF were tested (Table 2). However, when stratified by obesity level, these differences were only observed in the “overweight/obese” BMI ranges (>18.5 kg/m²) not in the “non-overweight/ non-obese” range. For SEAsian children: BMI $\beta = 1.42$ (0.54–2.33); waist $\beta = 0.51$ (0.17–0.75); %TBF $\beta = 0.44$, ($−0.01$ to 0.78) and in Australian children $\beta = 0.92$ (0.17 to 1.71), 0.32 (0.06 to 0.64), 0.36 (−0.02 to 0.61), respectively.

Stepwise regression modeling was undertaken to determine which obesity index was the strongest predictor of SBP: WC

### Table 1 | Baseline characteristics in 9-year-old Australian and SEAsian children living in Sydney stratified by obesity level

<table>
<thead>
<tr>
<th>Variable (either % or mean)</th>
<th>Normal weight$^a$ (n = 420)</th>
<th>Overweight$^b$ (n = 115)</th>
<th>Obese$^c$ (n = 59)</th>
<th>Total sample (n = 594)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Australian</td>
<td>SEAsian</td>
<td>P</td>
<td>Australian</td>
</tr>
<tr>
<td><strong>n (%)</strong></td>
<td>280 (74)</td>
<td>140 (65)</td>
<td></td>
<td>78 (20)</td>
</tr>
<tr>
<td>Female n (%)</td>
<td>111 (50)</td>
<td>57 (51)</td>
<td>0.92</td>
<td>55 (52)</td>
</tr>
<tr>
<td>High blood pressure, n (%)</td>
<td>18 (8)</td>
<td>10 (7)</td>
<td>0.72</td>
<td>14 (13)</td>
</tr>
<tr>
<td>PA outside school, n (%)</td>
<td>161 (76)</td>
<td>52 (38)</td>
<td>&lt;0.001</td>
<td>73 (72)</td>
</tr>
<tr>
<td>PA in school, n (%)</td>
<td>182 (82)</td>
<td>125 (38)</td>
<td>0.07</td>
<td>91 (87)</td>
</tr>
<tr>
<td>Low SES, n (%)</td>
<td>102 (46)</td>
<td>107 (76)</td>
<td>&lt;0.001</td>
<td>46 (44)</td>
</tr>
<tr>
<td>Age (years) mean ± s.d.</td>
<td>9 ± 0.4</td>
<td>9 ± 0.4</td>
<td>0.07</td>
<td>9 ± 0.5</td>
</tr>
<tr>
<td>Birth weight (kg) mean ± s.d.</td>
<td>3.3 ± 0.6</td>
<td>3.2 ± 0.5</td>
<td>0.05</td>
<td>3.5 ± 0.6</td>
</tr>
<tr>
<td>SBP (mm Hg) mean ± s.d.</td>
<td>109 ± 10</td>
<td>108 ± 9</td>
<td>0.66</td>
<td>113 ± 11</td>
</tr>
<tr>
<td>DBP (mm Hg) mean ± s.d.</td>
<td>58 ± 9</td>
<td>59 ± 8</td>
<td>0.15</td>
<td>60 ± 8</td>
</tr>
<tr>
<td>BMI (kg/m²) mean ± s.d.</td>
<td>16.3 ± 1.4</td>
<td>15.6 ± 1.1</td>
<td>0.06</td>
<td>20.6 ± 1.1</td>
</tr>
<tr>
<td>WC (cm) mean ± s.d.</td>
<td>56.4 ± 3.9</td>
<td>54.9 ± 3.5</td>
<td>&lt;0.001</td>
<td>63.5 ± 4.5</td>
</tr>
<tr>
<td>%TBF (mm) mean ± s.d.</td>
<td>6.9 ± 1.9</td>
<td>7.5 ± 3.0</td>
<td>0.02</td>
<td>11.7 ± 3.3</td>
</tr>
</tbody>
</table>

*Normal weight for Australian children: BMI < 19 kg/m²; normal weight for SEAsian children: BMI < 17.6 kg/m². Overweight for Australian children: 19 kg/m² ≤ BMI ≤ 23 kg/m²; overweight for SEAsian children: 17.6 kg/m² ≤ BMI ≤ 21 kg/m². Obese for Australian children: BMI > 23 kg/m²; obese for SEAsian children: BMI > 21 kg/m². %TBF: percent body fat; BMI: body mass index; DBP: diastolic blood pressure; PA: physical activity; SBP: systolic blood pressure; SEAsian, Southeast Asian; SES, socioeconomic status; WC, waist circumference.*
cant trends were seen at 12 years of age (data not shown).

Ethnicity, Child Obesity, and Blood Pressure

was found to the best predictor for SBP for SEAsian children ($r = 0.52$) and BMI for Australian ($r = 0.32$) children. When stratified by gender in both SEAsian boys ($r = 0.59$) and Australian girls ($r = 0.33$) WC was the strongest SBP predictor. However, BMI was the strongest SBP predictor for SEAsian girls ($r = 0.54$) and %TBF for Australian boys ($r = 0.33$) WC was the strongest SBP predictor.

Tests for interaction in linear regression models showed that with higher BMI or WC, SBP was significantly more elevated in SEAsian than Australian children (BMI × ETH $P_{interaction} = 0.50$, WC × ETH $P_{interaction} = 0.60$, %TBF × ETH $P_{interaction} = 0.07$). ANOVA also showed significant associations for all obesity indices: (BMI × ETH $P_{interaction} = 0.03$, WC × ETH $P_{interaction} = 0.02$, %TBF × ETH $P_{interaction} = 0.04$). These interactions are expressed graphically for all obesity indices in Figure 2. Similar but nonsignificant trends were seen at 12 years of age (data not shown).

Longitudinal changes

Longitudinal BMI change from age 9–12 years was only significantly associated with corresponding longitudinal SBP change in SEAsian children, not in Australian children; as was seen from the statistically significant interaction terms from both linear regression analyses (change BMI × ETH $P_{interaction} = 0.02$; change WC × ETH $P_{interaction} = 0.01$) and ANOVA analyses (change BMI × ETH $P_{interaction} = 0.03$; change WC × ETH $P_{interaction} = 0.05$). For SEAsian children a SBP increase of 1.70 mmHg was associated with each unit of BMI increase; compared to 0.80 mmHg for Australian children. Similar trends were observed with WC change but not for change in %TBF (Table 2). There was an interaction between baseline BMI and change in BMI for SBP in SEAsian children (change BMI × baseline BMI $P_{interaction} = 0.04$) but not in Australian children (change BMI × baseline BMI $P_{interaction} = 0.12$). Thus

![Figure 1](https://academic.oup.com/ajh/article-abstract/22/1/52/226804)

**Figure 1** | High systolic blood pressure (≥121 mm Hg) and overweight prevalence in Australian and Southeast Asian (SEAsian) children living in Sydney, Australia.

**Table 2 | Association between Obesity and SBP in Australian (n = 381) and SEAsian (n = 216) children living in Sydney**

<table>
<thead>
<tr>
<th>Baseline obesity index</th>
<th>Boys and girls (n = 597)</th>
<th>9-Year-old children</th>
<th>Girls (n = 301)</th>
<th>Longitudinal obesity index</th>
<th>Boys and girls (n = 302)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys (n = 296)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>380.32 1.05 &lt;0.001</td>
<td>1.05</td>
<td>1.20</td>
<td>185</td>
<td>0.37</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>381.31 0.38 &lt;0.001</td>
<td>0.73</td>
<td>0.97</td>
<td>186</td>
<td>0.35</td>
</tr>
<tr>
<td>%TBF (mm)</td>
<td>381.20 0.45 &lt;0.001</td>
<td>0.73</td>
<td>0.97</td>
<td>186</td>
<td>0.35</td>
</tr>
<tr>
<td>SEAsian, n = 216</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>214.50 1.51 &lt;0.001</td>
<td>1.05</td>
<td>0.20</td>
<td>106</td>
<td>0.53</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>214.06 0.56 &lt;0.001</td>
<td>0.42</td>
<td>0.68</td>
<td>108</td>
<td>0.59</td>
</tr>
<tr>
<td>%TBF (mm)</td>
<td>216.04 0.65 &lt;0.001</td>
<td>0.58</td>
<td>0.84</td>
<td>110</td>
<td>0.48</td>
</tr>
<tr>
<td>Longitudinal change</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>BMI (mm)</td>
<td>0.35 0.20 0.001</td>
<td>1.05</td>
<td>0.20</td>
<td>106</td>
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<td>110</td>
<td>0.48</td>
</tr>
</tbody>
</table>

%TBF, percent body fat; BMI, body mass index; SEAsian, Southeast Asian; SES, socioeconomic status; WC, waist circumference.

† Missing data: BMI Australian, n = 1; SEAsian, n = 2; WC SEAsian, n = 2. **Adjusted for age, SES, birth weight and physical activity. *Adjusted for age, SES, birth weight, physical activity and, baseline obesity index where relevant.
it appears that relatively thinner children at age 9 exhibited greater increase in SBP with increasing BMI. Similar but non-significant trends to those reported above were also observed between SEAsian children born in Australia and in Southeast Asia (data not shown).

**DISCUSSION**

Our findings suggest that SEAsian children living in Australia at are at higher risk of increased SBP than their Australian-counterparts when they gain body mass or WC. The high correlations found between BMI and SBP in SEAsian children living in Australia are very similar to those reported for children of similar age from China (2000 n = 1,322 r = 0.56),6 and from Hong Kong (2007 n = 2,593 r = 0.6).22 The latter study reported almost identical correlations to our findings for WC (r = 0.5 girls; r = 0.6 boys).22 Two comparable Asian studies, one from Japan (1990 n = 324)27 and another from urban Shijiazhuang province (2007 n = 913)7 reported very similar risks for increased SBP for overweight/obese children (OR = 6.8, 95% CI = 4.2–11).7 Recently Jafar et al. reported a two-fold difference in hypertension (adjusted for BMI) between Pakistani children (n = 5,641 5–14-years old) with 4,756 white children from NHANES-III.28

An association between increased obesity and hypertension in Caucasian children has been consistently reported since the early 1990s.29–33 Since then, studies from North America ranging in size from n= 7,345 to 471,90610,19,34–36 have reported this association as well as studies from South America,37 Southern9 and Northern Europe,38 and Australia.26 There has been a reported tendency for blacks and Hispanics to be at higher risk of hypertension with increasing obesity than whites35 but to our knowledge this study is the first to compare SEAsian immigrants to their counterparts in their adopted country.

The potential reasons for this ethnic variation in the relationship of overweight/obesity and change in SBP could be either genetic or environmental, and maybe a combination of the two. As results reported from China are similar to ours,6,22 this suggests a genetic, possibly a body frame difference in Asians compared to white Caucasian children. One hypothesis is that those children who have a smaller body frame track with respect to increased SBP at a higher rate when they increase in obesity-related indices. Alternatively, and possibly additionally, children when exposed to environments where foods are higher in calories and where there is more access to cars and transport will take on these habits more than their nonmigrant peers. We have some evidence for this with the differences exhibited by children born in Southeast Asia compared to those born in Australia, and also by the lower levels of engagement in outside school PA exhibited by the SEAsian than Australian children in our study. These findings are of particular relevance in Australia because the proportion of SEAsian migrants has doubled from 1996–1997 and 2005–2006; from 7 to 14%.39

To our knowledge the findings presented here in regard to SEAsian children, along with those of Jafar et al.28 are the first to compare the effects of increased obesity on SBP in children that, to now, have traditionally been thought not to be at risk for obesity or hypertension. The strengths of this study are fourfold. First, all the BP and anthropometric measures used were individually measured with high reliability and validity.15 Second, not just BMI but two other measures of obesity were used (WC and %TBF), and these indices better indicate weight distribution and body fat than BMI alone. Third, SEAsian ethnicity was defined by country of birth of either the child or at least one parent, a more meaningful measure than language spoken at home, which has been used in previous Australian and other studies.40 Fourth, to our knowledge our data are the first and only comparison, both cross-sectionally and longitudinally, of the relationship between SBP and obesity-related indices in SEAsian children living in Australia.

The study limitations are also fourfold: first, because this study had relatively small sample sizes for each ethnic group.
this limits statistical power to detect significant effects especially on follow-up (this partly explains the lack of significant findings for %TBF on follow-up). Second, although the study children were from randomly selected schools, the response rate was only 51%, and there was almost 50% attrition between the baseline and follow-up surveys. However, as study children were compared with themselves, factors affecting SBP would still be revealed. In addition as it appears the nonresponders were of higher BMI, WC and %TBF; were from lower SES and had lower levels of PA outside school (Supplementary Table S1 online), we would expect a bias toward the null in our data. Third, despite the fact that we measured SBP three times at each sitting, SBP is still subject to variability emanating from stress and personality factors and this may constitute measurement bias.15,20 In this study the mean of the second and third successive BP readings was used. These should on average, be expected to decline successively toward a “true” resting value as the children become more familiar and less anxious with the procedure.20 The validity of the BP measures may be more questionable, if it purported to be that for a whole population, rather than used to compare differences between population subgroups, as in the case of this study. That is, if the BP measures were biased in one direction or another, it should not be expected that this bias be differential according to the subgroups compared in this study. Accordingly, from these considerations, we conclude that the group differences in BP found in this study, both cross-sectional and longitudinal, are valid and reliable. Finally, as with any epidemiological study, the results may still be due to chance. However, the data were initially collected on a random sample of schools and our reported results are consistent across the three obesity indices used. Selection bias toward low SES children in SE Asian children may exist, but when we adjusted for SES our findings remained significant.

Conclusion and public health implications and recommendations

Our findings suggest that SE Asian children living in Australia are at higher risk of increased SBP than their Australian counterparts when they gain body mass or body fat. The reasons for this need exploration and could be either genetic, environmental or a combination/interaction of the two. This phenomenon could have important public health consequences in a context of increasing childhood obesity in both developed and developing countries. Thus we suggest these findings be further investigated in larger studies of immigrant Asian populations in developed countries.

There is ample evidence that increased PA reduces SBP.41 Accordingly, we suggest the establishment of ethnic-specific programs to increase PA in school children in Australia and in those countries who have similar immigrant population health patterns and behaviors.

Supplementary material is linked to the online version of the paper at http://www.nature.com/ajh

Disclosure: The authors declared no conflict of interest.


15. Moorrel SL. Aircraft noise and child blood pressure. School of Public Health, University of Sydney, Sydney, Australia, 2006.


