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To the Editor:

Socioeconomic position (SEP) is a well-established determinant of health.[1] In general, people with higher SEP have better health.[1] Income is frequently used as a proxy measure of SEP. However, reliable family-level income data is often unavailable for studies involving families with children. To overcome this, area-based measures of income are often used as a proxy for family income; typically using median neighbourhood income from census data.[1,2] Studies which have assessed the agreement between family-level and neighbourhood-level income measures have yielded conflicting results.[1-5] Some have identified poor agreement between the income measures while others have reported reasonable agreement depending on the patient population.[1-5] The agreement between family-level income and neighbourhood-level income for families with children has not been evaluated. In this letter we aim to evaluate the agreement between family-level and neighbourhood-level measures of income in an urban population of families with young children.

Families with healthy children age 0-5 years were recruited October 2011 through July 2012 from the TARGet Kids! practice based primary care research network in Toronto, Canada. 'Family-level income' was measured by parent report using the following question, "What was your total family income before taxes last year?": <\$10,000, \$10,000-\$19,999, \$20,000-\$29,999, \$30,000-\$39,999, \$40,000-\$49,999, \$50,000-\$59,999, \$60,000-\$79,999, \$80,000-\$99,999, \$100,000-\$149,999 or >\$150,000.

'Neighbourhood-level income' was defined as the median income for the dissemination

area (DA) in which the family lives, using the same income categories. This was determined by linking family postal code to a DA. Median DA income was determined using 2006 Canadian Census data. To equate 2006 neighbourhood-level income data with the 2012 TARGet Kids! family-level income data, 2006 neighbourhood-level income data was multiplied by an inflation factor of 12.07%, which was established using the Bank of Canada inflation calculator derived from the Canadian Consumer Price Index.[1,4,6] The agreement between family-level and neighbourhood-level income measures was evaluated using kappa coefficients (weighted and unweighted) and Spearman's correlation coefficient. The overall accuracy, overall misclassification and trends in misclassification of neighbourhood-level income were evaluated, using family-level income as the reference. Overall accuracy was defined as the percentage of families that were classified correctly and overall misclassification was defined as the percentage of families that were classified incorrectly. To identify systematic trends in misclassification, the percentage of families misclassified for each income category was calculated. We also explored whether misclassification was an overestimation or underestimation, and by how many income categories (i.e. 1, 2, or ≥ 3).[5]

Overestimation was defined as a neighbourhood-level income category that was greater than the family-level income (i.e. \$80,000-\$99,999 when the family-level income is \$60,000-\$79,999 is an overestimation by 1 income category). Underestimation was defined as a neighbourhood-level income that was less than the family-level income.

Of 1878 eligible families, 1689 families (90%) had both family-level income and neighbourhood-level income and were included in the analysis. Agreement between the

two income measures was poor (unweighted kappa 0.05 [95%CI:0.03-0.07]; weighted kappa 0.22 [95%CI:0.19-0.25]), as was the association between the two measures (Spearman's correlation coefficient=0.38). The overall accuracy of classification was 20%. The percentage of incomes classified correctly tended to improve with higher family-level income. The overall misclassification was 80%, with 58% of family-level incomes underestimated by neighbourhood-level income and 22% of family-level income overestimated by neighbourhood-level income (see Table 1). Neighbourhood-level income tended to overestimate family-level income for family-level incomes less than \$80,000, and underestimate family-level income for family-level incomes greater than \$80,000 (see Figure 1).

One explanation for our finding that lower family-level income tended to be overestimated by neighbourhood-level income and higher family-level income tended to be underestimated by neighbourhood-level income is that neighbourhood-level income is a median. By using a median, the income extremes within a neighbourhood are lost. Therefore the median neighbourhood-level income would be expected to be lower than the self-reported family-level income of higher earning families and higher than the measured family-level income of lower earning families. Another is that the validity of neighbourhood-level income as a proxy for family-level income relies on the assumption that family incomes within a dissemination area are reasonably homogenous.[4] In a diverse urban population this may not be the case due to the wide range of family-level incomes concentrated in a relatively small area.

Our findings suggest that the utility of neighbourhood-level measures of income as a proxy for family-level measures of income among families with young children may be

limited. We suggest that future studies which require income measurement use reported family-level income where possible. Since access to reliable family-level income data is often challenging, future research investigating other potential proxies for family-level income would be valuable.

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Table 1. Trends in misclassification of neighbourhood-level income according to family-level income

Misclassification of neighbourhood-level income							
	Underestimation			Correct classification	Overestimation		
	N (%)			N (%)	N (%)		
Family-level income	-3	-2	-1	0	1	2	≥3
<10,000	--	--	--	0 (0)	0 (0)	0 (0)	20 (100)
10,000 – 19,999	--	--	0 (0)	0 (0)	0 (0)	5 (18)	23 (82)
20,000 – 29,999	--	0 (0)	0 (0)	1 (2)	6 (13)	10 (21)	30 (64)
30,000 – 39,999	0 (0)	0 (0)	0 (0)	4 (9)	10 (22)	7 (16)	24 (53)
40,000 – 49,999	0 (0)	2 (3)	0 (0)	4 (7)	14 (25)	19 (33)	18 (32)
50,000 – 59,999	0 (0)	2 (3)	4 (7)	8 (14)	20 (34)	13 (22)	12 (20)
60,000 – 79,999	2 (2)	8 (7)	9 (8)	29 (26)	41 (36)	20 (18)	3 (3)
80,000 – 99,999	10 (6)	7 (4)	54 (33)	37 (23)	45 (28)	9 (6)	--
100,000 – 149,999	45 (12)	75 (19)	102 (27)	140 (36)	24 (6)	--	--
>150,000	157 (20)	189 (25)	304 (39)	123 (16)	--	--	--
Total	214 (13)	283 (17)	473 (28)	346 (20)	160 (9)	83 (5)	130 (8)
Overall totals*	970 (58)			346 (20)	373 (22)		

*Overall underestimation, overall accuracy and overall overestimation, respectively

Simple Kappa = 0.05 (95% CI: 0.03-0.07).

Weighted Kappa = 0.22 (95% CI: 0.19-0.25).

Spearman's correlation coefficient = 0.38.

Figure 2. Neighbourhood-level income vs. family-level income.

Black line represents trend line. Yellow line represents perfect agreement (slope=1).

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