SHORT COMMUNICATION

Body image and C-reactive protein in adolescents

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Background: The association between inflammation and obesity is well documented; however, there is little evidence linking physiological markers of inflammation and psychosocial factors such as body image. This study examined the relation between body image and C-reactive protein (CRP).

Methods: Data were available for 1503 adolescents aged 13 and 16 years in a province-wide survey of a representative sample of youth in Quebec, Canada. Participants completed questionnaires assessing body image indicators of social pressures to lose weight and personal body shape discrepancies, provided a fasting blood sample for CRP, and had height and weight measured.

Results: In separate multivariable logistic regression models for girls and boys, body shape discrepancy was positively associated with CRP (boys: OR = 2.6, 95% CI = 1.4–4.8; girls: OR = 2.2, 95% CI = 1.2–4.3) independent of body mass index, puberty status and socio-demographic variables.

Conclusions: Adverse biological markers of cardiometabolic risk and negative body image are associated in adolescence. These findings suggest that, in addition to the well-known psychological problems, negative body image perceptions may also threaten adolescent’s physical health.

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Keywords: body dissatisfaction; cardiometabolic risk; body mass index; mental health

Background

C-reactive protein (CRP) is a systemic proinflammatory marker that is associated with many health conditions.¹,² Whereas biological factors such as body mass index (BMI) are well-known correlates of elevated CRP in children and adults,³,⁴ few reports investigate the importance of psychosocial factors in immune function.

Body image, defined as an individual’s thoughts (cognitions) and feelings (affect) about his/her weight and body shape,⁵,⁶ may be an important psychosocial factor linked to adolescent health. Comments about one’s body size/shape and being encouraged to change one’s weight may translate into negative affective experiences of body image.⁷ Further, discrepancies between an individual’s current body shape and his/her desired or ‘ideal’ body shape is a cognitive dimension of body image that is associated with negative affect and stress.⁵,⁶

Body image may relate to elevated CRP in adolescents for several reasons. First, body image is associated with BMI, and BMI is linked to elevated CRP.³,⁴ Second, both BMI and body image are salient stressors during adolescence.⁹ Third, body image stress relates to affect, cognition and health behavior in ways similar to those of general stress.¹⁰ Finally, general stress is linked to immune function.¹¹ To date, stress related to body image has not been examined as a possible correlate of elevated CRP. We propose that negative body image in adolescents, assessed as affective (pressure to lose weight) and cognitive (dissatisfaction with one’s body shape) domains,⁸ results in a psychobiological activation that is evident in elevated CRP.

Methods

Data were drawn from the 1999 Quebec Child and Adolescent Health and Social Survey (QCAHS), which has been described elsewhere.⁴,¹² Briefly, the QCAHS included three independent representative samples of youth aged 9, 13 and 16 years selected based on a province-wide cluster sampling design. Assessments included height and weight measured using a standardized protocol,¹³ a fasting blood
sample and a self-report questionnaire with items measuring body image. Parents reported socio-demographic items. The QCAHS was approved by the ethics review board of Direction Santé Québec, Institut de la statistique du Québec and CHU Sainte-Justine. Written informed consent was obtained from the adolescents and their legal guardians.

The current study was restricted to 1503 participants aged 13 and 16 years with available blood specimens, measured height and weight and self-report data.

Two valid and reliable affective body image indicators assessed social pressures to change weight/body shape:7 ‘Do the following people (mother, father, siblings, friends, others) ever…. (i) make negative comments about your weight?, and (ii) encourage or push you to lose weight?’ Adolescents were classified as receiving negative comments about their weight if they reported ‘yes’ to at least one of these items. Similarly, they were classified as being encouraged to diet if at least one item was endorsed.

To measure body dissatisfaction, participants were asked to indicate which of seven sex-specific body shapes depicting same-height individuals of increasing body size ‘best corresponds to… (i) your current appearance and …(ii) what you’d like to look like.’14 Figure rating body image measures have demonstrated reliability and validity in child, adolescent and adult populations and have been identified as cognitive body image indicators.5,6,8,14–16 A discrepancy score was calculated as the absolute value of the reported ideal body shape minus current body shape. For the current study, a score of 2 or more revealed body dissatisfaction because we felt that differences of two or more body shapes represented a strong indication for desired change.

Participants were classified as having elevated CRP if their value was equal to or greater than the 90th percentile of the sample-based age- and sex-specific CRP distributions (≥2.25 and ≥3.28 mg/l for boys aged 13 and 16 years; ≥1.78 and ≥4.34 mg/l for girls aged 13 and 16 years).

Age and sex were drawn from the adolescent questionnaire. Puberty status17 was classified as the following based on participant reporting: (1) ‘pre-pubertal’ for no body hair growth and no menstruation or breast growth (girls), or no facial hair growth or deepening of the voice (boys); (2) ‘pubertal’ if there was any indication of body hair growth and breast growth and/or menstruation (girls), or facial hair growth and/or voice changes (boys). Because ongoing infection may be associated with elevated CRP levels, use of medications (antibiotics, medications for pain/fever, colds/allergies and/or respiratory problems) in the 2 weeks before the data collection was drawn from the participant questionnaire. Given the emerging link between socioeconomic status and elevated CRP levels,18 data on household income and parental level of education (elementary school, secondary school, trade school, college/university) were drawn from the parent questionnaire. Finally, measured height and weight were used to calculate BMI (weight in kilograms/height in meters squared). Age- and sex-specific BMI z-scores, based on the Centers for Disease Control growth charts, were used in the analyses.

### Analysis

Odds ratios (OR) for elevated CRP were derived in multivariable logistic regression adjusting for parental education, household income, inflammation medications taken in the last 2 weeks, age, puberty and BMI z-scores. Interaction effects were examined for weight status and age.

### Results

There were few differences between the analytic sample and participants excluded from the analysis (Table 1).

Two of the three body image indicators were associated with CRP in univariate analysis (Table 2, Model 1). Body dissatisfaction remained significantly correlated with elevated CRP in the model for adolescent boys (OR = 2.6, 95% CI = 1.4–4.8) and girls (OR = 2.2, 95% CI = 1.2–4.3), when all control variables were included in the model. The interaction effects tested were not significant, suggesting that the associations observed were not modified by BMI or age.

### Discussion

This analysis examined the association between indicators of body image and CRP in 13- and 16-year-old adolescents. On the basis of the findings, it is possible that body image is important in immune system function beyond the well-established association between CRP and weight status. This cross-sectional evidence that psychosocial factors such as

### Table 1 Comparison of selected socio-demographic characteristics of participants retained for analysis with those of participants not retained

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Participants retained for analysis (n = 1503)</th>
<th>Participants who were not retained for analysis (n = 895)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>52</td>
<td>50</td>
</tr>
<tr>
<td>Age 16 years</td>
<td>53*</td>
<td>47</td>
</tr>
<tr>
<td>Puberty</td>
<td>87</td>
<td>87</td>
</tr>
<tr>
<td>At least 1 parent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; secondary school</td>
<td>92*</td>
<td>88</td>
</tr>
<tr>
<td>Household income ≥ $50,000</td>
<td>49</td>
<td>53</td>
</tr>
<tr>
<td>Inflammation medications taken in the last 2 weeks (yes)</td>
<td>56*</td>
<td>50</td>
</tr>
<tr>
<td>BMI z-score ≥ 2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative comments about weight (yes)</td>
<td>6.4</td>
<td>6.5</td>
</tr>
<tr>
<td>Encouraged to diet (yes)</td>
<td>31</td>
<td>28</td>
</tr>
<tr>
<td>Body dissatisfaction (absolute discrepancy ≥ 2)</td>
<td>12</td>
<td>13</td>
</tr>
</tbody>
</table>

Abbreviation: BMI, body mass index. *P < 0.05.
Body image may be important correlates of cardiometabolic risk in adolescents should be investigated longitudinally.

Much like other psychological factors, it may be that body dissatisfaction relates to immune processes in ways similar to general stress. These include changes in plasma volume, upregulated synthesis of inflammatory markers and increases in the number of cytokine-synthesizing cells contributing to circulatory levels. The novel finding that perceptions of body dissatisfaction are associated with CRP adds to a limited body of knowledge linking body image to physiological manifestations of stress and immune system function. Putterman and Linden showed dysfunctional cognitions of appearance and body image contributed to elevated levels of cortisol excretion in adults. Their results and the current findings highlight the need to contextualize specific types of stress and anxiety (that is, body-related cognitive stress) to better understand the links to immune function specifically and to health more generally. Body image is linked to mental health, whereby greater body dissatisfaction is correlated with negative affect and depression. Our findings suggest that body image is also linked to biological markers of cardiometabolic risk. It is important to increase understanding of the importance of body image in both mental and physical health.

Elevated CRP was significantly associated with adolescent boys’ reports of being encouraged to lose weight by significant others (parents, siblings and friends) to lose weight. This relationship did not hold after controlling for BMI, and could simply imply that larger boys may be encouraged to lose weight and, independently, have elevated CRP levels. It may nonetheless be important that significant others are made aware of the need to provide supportive comments about body shape and size rather than focus on encouraging weight or body shape changes. The chronic effects of being encouraged to diet on mental and physical health are unknown, and this gap in our knowledge must be addressed to better inform clinical practice.

The figure rating shapes used in the current study were originally developed for use with children who were asked to indicate their desired body shape when they grow up. This may be a limitation in the measure of discrepancy scores. The cross-sectional design is also a limitation to understanding the directionality of effects. Future research should investigate the physiological and psychological pathways linking body image and CRP using longitudinal data. Also, the relationships between CRP and the multiple dimensions of body image, aside from the cognitive and affective domains studied here, should also be explored.

Overall these results highlight the need for practitioners working with adolescents to focus on both weight status and perceived weight status. Adverse biological markers of cardiometabolic risk and negative body image are associated in adolescence. These findings suggest that, in addition to the well-known psychological problems, negative body image perceptions may also threaten adolescent’s physical health.

### References

15. Banasiak SJ, Werthheim EH, Koerner J, Voudouris NJ. Test–retest reliability and internal consistency of a variety of measures of body image and C-reactive protein

### Table 2

<table>
<thead>
<tr>
<th>OR and 95% CI in the logistic model for elevated CRP levels according to body image indicators</th>
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<tbody>
<tr>
<td><strong>Boys</strong></td>
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<tr>
<td>-----------------</td>
</tr>
<tr>
<td><strong>Encouraged to diet</strong></td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td><strong>Body dissatisfaction</strong></td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

Abbreviation: BMI, body mass index. *P < 0.001. *Adjusted for BMI z-score, age, puberty status, parental education, household income and inflammation medications taken in the last 2 weeks.
dietary restraint and body concerns in a sample of adolescents. *Int J Eat Disord* 2001; 29: 85–89.


