A Multilevel Study of the Associations Between Economic and Social Context, Stage of Adolescence, and Physical Activity and Body Mass Index

Caroline Mae McKay, PhD, Bethany A. Bell-Ellison, MPH, Kirsten Wallace, MA, MSPH, John M. Ferron, PhD

METHODS. Analysis used a subset of adolescents aged 10 to 17 years from the National Survey of Children’s Health (n = 37,930) from all states and the District of Columbia (n = 51). Dependent variables included physical activity and BMI. State-level economic context was measured by the proportion of families living below 200% of the federal poverty level. Social context was measured by aggregated means of responses to 2 indicators of social capital: mutual aid and social trust. Multilevel modeling was conducted to investigate associations between state-level economic and social context and physical activity and BMI, while controlling for individual sociodemographic characteristics, and whether these associations were dependent on an individual’s stage of adolescence.

RESULTS. Both state-level mutual aid and social trust were significantly related to the odds of an adolescent not meeting current physical activity recommendations, yet state-level poverty was not. For BMI, all 3 state-level variables were significant predictors of having an above-normal BMI. Evidence was found of the moderating influence of stage of adolescence for both outcomes.

CONCLUSIONS. These findings point to the need for the inclusion of contextual-level data in surveillance systems assessing risk behavior in adolescents and consideration of the multilevel nature of the growing problem of inactivity and above-normal weight when focusing public health prevention efforts.
On the cardiovascular system begin in childhood.1,2 Obesity and inactivity are consistently implicated in the pathogenesis of many chronic diseases, such as cardiovascular disease and diabetes. Almost 30% of adolescents in the United States are at risk of or are overweight, with disparities because of gender, race, and ethnicity: socioeconomic status, and stage of adolescence.3,4 Similarly, >30% of adolescents do not engage in regular physical activity (PA),1,5 with levels varying across sociodemographic characteristics and geographic location.3,4 These behavioral risk factors are often targeted with individual change prevention strategies, which have had limited effectiveness.6 This status is attributable, in part, to the decontextualized manner in which most health promotion and behavior change interventions are created, with little concern for the features and influence of place.7

Despite this focus, there is growing evidence affirming the negative impact of area-level poverty on behavior. Findings support the structural influence of material deprivation above and beyond individual status on such risk factors as PA and obesity.8 Results indicate not only a significant negative association between poverty and PA,9-12 but also a possible dose-response effect between area factors and activity.13 Moreover, the increased risk of obesity for those who live in poverty has been well-established,8,14 with associations for independent12 as well as mediated effects.10

The reliance on intraindividual determinants to the exclusion of broader societal influences, which construct or shape risk behavior,15 is seen in most studies of chronic disease. Just as the physical environment either inhibits or facilitates health behavior, so does the social or collective characteristics of the community.16,17 One way in which the environment “gets under one’s skin” and influences physiology is through its effect on risk behaviors, such as PA and diet.18,19 Studies have examined both physical and social aspects or multiple dimensions of the environment.12,20-22 Findings suggest that there is a positive association between socially cohesive environments and PA.21 In addition to personal factors such as enjoyment and preferences influencing activity levels, attributes of the collective (eg, social disengagement) negatively influence health behavior.23 For example, those living in socially disengaged areas have over twice the odds of low PA, with little differential effect by individual factors.24 Also, although more limited, there is evidence of a positive association between area of residence and obesity,25,26 with explicit findings of the impact of a weakened social context and poor diet and obesity.12,27,28

Within the adolescent health literature, there is growing recognition of the central threat of obesity on future morbidity for these individuals. The association between context and being overweight or inactive in adolescence may depend on age or stage of development.29 Moreover, transitions between early, middle, and late adolescence and developmental processes may shape behavior and future cardiovascular disease risk.30 However, the role of development has not been well studied regarding its possible moderating effects on contextual influences on behavior. The purposes of this study were to (a) examine the influence of the economic context of the states in which adolescents reside on the odds of being inactive or having above-normal weight, (b) examine the influence of the social context of the communities in which adolescents live on the odds of being inactive or having above-normal weight, and (c) to determine whether these influences differed on the basis of stage of adolescence.

METHODS

Sample

Data for the study were drawn from the 2003 National Survey of Children’s Health (NSCH), a nationally representative sample of children with a focus on the physical and emotional health of children 0 to 17 years of age.31 The survey design is described briefly in the article by Kogan and Newacheck12 in this issue; more in-depth information can be found elsewhere.31 For this study, the original NSCH sample (N = 102 353) was limited to children between 10 and 17 years of age of normal weight, at risk for overweight, or overweight (n = 46 529) and was further restricted to individuals with complete data on all variables of interest, resulting in a final sample of 37 930. All 50 states and the District of Columbia were represented in the analyses, with the number of adolescents per state ranging from 514 to 918.

Variables

The first criterion variable in the analyses was amount of PA, dichotomized as meeting current recommendations or not (0 and 1, respectively). Recommended levels of exercise for this population included participating in moderate or vigorous activity 20 minutes or more most days of the week.31 The other outcome of interest, BMI, was dichotomized as normal or above-normal (0 and 1, respectively). Cutoff points for assessment of age-adjusted BMI were derived from the NSCH and previous research.14 BMI values representing both at risk for overweight and overweight were used in this study as indicators of above-normal BMI.

Level-1 control variables in all analyses included gender (0 = male, 1 = female), family income (% federal poverty level [FPL]), race (0 = white, 1 = not white), and ethnicity (0 = non-Hispanic, 1 = Hispanic). Stage of adolescence was examined for its possible moderating effects and was coded 0 = early (10–13 years), 1 = middle (14–16 years), and 2 = late (17 years).35 Percep-
tions of social trust (“If my child were outside playing and got hurt or scared, there are adults nearby who I trust to help my child”) and mutual aid (“People in this neighborhood help each other out”) were also included as control variables when state-level social trust and mutual aid were included in the analyses. Both items were measured on a 4-point Likert scale, with response options ranging from definitely agree to definitely disagree. Response options for both variables were reverse-coded, with higher numbers representing higher levels of agreement with each of the statements. Family income was also reverse-coded, with higher numbers representing higher levels of poverty.

Level-2 variables included an economic indicator, state-level poverty, and 2 social contextual indicators: state-level social trust and mutual aid. State-level poverty was measured as the proportion of the state’s population living below 200% of the FPL. Below 200% of the FPL was chosen because it encompasses common poverty thresholds used for determining eligibility for state and federal assistance (eg, Head Start, Food Stamp Program, National School Lunch Program). State-level social trust and mutual aid were both measured as aggregated means of previously described variables assessing individual perceptions of social trust and mutual aid. Consistent with previous multilevel studies of contextual influences on health, state-level aggregates of economic and social indicators were used because the data set did not explicitly include contextual variables at the regional or local level.

Analysis
Descriptive statistics were examined for level-1 and level-2 variables by using SAS 9.13. Analyses were weighted to produce representative estimates of the US population 10 to 17 years of age. Missing data on the children excluded from the current analyses were also examined by using SAS 9.13 to determine to what extent the missingness seemed to be random.

Research questions were examined by using multilevel models, with individuals nested within states, using hierarchical generalized linear modeling in HLM 6. A total of 10 models were examined for each criterion variable (PA and BMI). All models were estimated by using restricted penalized quasi-likelihood, with a Bernoulli distribution at level 1. All level-2 variables and individual poverty, social trust, and mutual aid at level 1 were grand-mean centered. A description of each of the models examined is presented later.

For PA, an unconditional model examined the odds of not meeting current PA recommendations in a typical state and assessed if the odds varied across states (model 1). Next, 3 different level-1 control models tested to what extent not meeting current PA recommendations varied with gender, race, ethnicity, poverty, stage of adolescence (model 2a), and perceptions of mutual aid (model 2b) or perceptions of social trust (model 2c). Subsequently, 6 level-2 models were tested. The first level-2 model identified whether not meeting current PA recommendations varied across states of differing poverty levels (model 3) and the next level-2 model tested whether the association between state poverty and not meeting current PA recommendations depended on an individual’s stage of adolescence (model 4). The next 2 models examined whether not meeting current PA recommendations varied across states of differing levels of mutual aid (model 5) and whether the association between state mutual aid and not meeting current PA recommendations depended on an individual’s stage of adolescence (model 6). The last 2 models tested whether not meeting current PA recommendations varied across states of differing levels of state trust (model 7) and whether this association depended on an individual’s stage of adolescence (model 8). The same 10 models were examined for BMI. All procedures for the study were approved through the University of South Florida’s Institutional Review Board.

RESULTS
Weighted descriptive statistics of the adolescents included in the current analyses reveal that at the individual level there was almost equal representation of boys and girls (51% vs 49%, respectively), and the majority of adolescents were white (76%), non-Hispanic (93%), and between the ages of 10 and 13 years (50%). Nearly two thirds of adolescents lived in households above 200% of the FPL; more than half of the adolescents did not meet current PA recommendations (53%); and nearly one third (31%) had an above-normal BMI. On average, parents of participating youth reported relatively high levels of social trust (mean: 3.6) and mutual aid (mean: 3.2). Regarding state-level characteristics, on average, states had a moderate proportion of families residing below 200% of the FPL (mean: 0.36) and relatively high levels of mutual aid and social trust (mean: 3.3 and 3.6, respectively). Table 1 provides more details regarding demographic characteristics for both level-1 and level-2 variables. In terms of missing data, there does not seem to be much correlation between missingness on the 8 variables that had missing values; coefficients ranged from −0.01 to 0.49, with only 5 associations with absolute values ≥0.3.

A summary of results from the hierarchical linear modeling analyses are presented in Tables 2 and 3. In regards to contextual influences on PA, after controlling for individual characteristics, no association was found between state-level economic context and adolescents’ PA levels, but significant relationships were found for both state-level mutual aid and social trust. More specifically, the odds of an adolescent not meeting recommended levels of activity was not significantly associated with the area-level poverty of the state within which he

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or she resided; however, the odds of an adolescent not meeting current recommended levels of PA was associated with both area-level mutual aid and social trust. The strength of the relationship between state-level mutual aid and not meeting current PA recommendations depended on an adolescent’s stage of development, such that regardless of adolescent stage, youth residing in states with higher levels of mutual aid had increased odds of not meeting current PA recommendations. However, the influence of state-level mutual aid was greatest among younger adolescents (odds ratio [OR]: 0.50; 95% confidence interval [CI]: 0.27–0.95). The odds of an adolescent having a above-normal BMI was also related to area-level mutual aid and social trust, with both relationships dependent on an adolescent’s stage of development (OR: 1.68, 95% CI: 1.07–2.64; OR: 3.11, 95% CI: 1.50–6.47, respectively). The same interaction pattern was observed for state-level mutual aid and social trust; for early adolescence (ages 10–13), youth who lived in states with high levels of mutual aid and social trust had the lowest odds of having an above-normal BMI; however, for late adolescence (age 17), youth who lived in states with higher levels of mutual aid and social trust had the greatest odds of having an above-normal BMI. Five individual characteristics were significantly related to the odds of an adolescent having an above-normal BMI. Younger, poor, male, nonwhite, and Hispanic adolescents had increased odds of having an above-normal BMI. On the basis of these results, it seems that the economic context of an adolescents’ community is related to his or her BMI, and the social context of the community in which adolescents reside may influence their BMI and whether they engage in recommended levels of PA.

DISCUSSION

Although the findings did not show a consistent pattern with respect to PA and BMI, there was evidence of contextual influences and the possible role of stage of development in shaping the effects. It seems both the direction of effect and mechanisms underlying the relationships of broader socioeconomic factors and risk may operate differently depending on adolescent’s age and behavioral outcome. The complexity of results points to the possible differential moderating effect of stage of adolescence on the basis of the specific feature of development that is being examined (eg, physical preoccupation with body image compared with focus on peer influence and independence). Overall, this study presents additional evidence that the environment provides opportunities or barriers for agency. This investigation points to the current need for knowledge regarding the effects of broader determinants of health on adolescent risk. Public health implications of these findings include impact on both practice-related activities (eg, primary prevention) and policy-related endeavors, (eg, interventions aimed at improving wider environmental aspects of health).

However, there are certain limitations. One factor,
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<th>Model 4, OR (95% CI)</th>
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<th>Model 6, OR (95% CI)</th>
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Values are based on HGLM in HLM 6.

$p < 0.05$
### TABLE 3 Results Summary Table: Hierarchical Generalized Linear Models for BMI

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<td>× state poverty</td>
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<tr>
<td>Adolescent stage</td>
<td></td>
<td>1.68 (1.07–2.64)</td>
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<td>× state mutual aid</td>
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<tr>
<td>Adolescent stage</td>
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<td>3.11 (1.50–6.47)</td>
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<td>× state social trust</td>
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<td>Variance components</td>
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<tr>
<td>Error variance in Intercepts</td>
<td>0.02*</td>
<td>0.01*</td>
<td>0.009*</td>
<td>0.013*</td>
<td>0.01*</td>
<td>0.01*</td>
<td>0.01*</td>
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<tr>
<td>Error variance in adolescent stage effect</td>
<td>0.006*</td>
<td>0.01*</td>
<td>0.003*</td>
<td>0.003*</td>
<td>0.002*</td>
<td>0.002*</td>
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<td>0.002*</td>
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<tr>
<td>Intercept/adolescent stage covariance</td>
<td>−0.005</td>
<td>−0.002</td>
<td>−0.002</td>
<td>−0.002</td>
<td>−0.002</td>
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</table>

Values are based on HGLM in HLM 6.

*aP < .05
which may have influenced the results, is that the data set has a truncated sample of late-stage adolescents; only age 17 is available, not a more valid 17- to 19-year-old range within the sample. Another concern is the use of age-adjusted BMI, in that there is some debate as to the validity and reliability of using certain cutoff points in this population. In addition, the inconsistency of results between the effects of economic and social contextual influences may be because of 2 issues. Only single items are used as measures of contextual constructs. Also, the use of states as aggregated level-2 areas may be less theoretically valid to conceive state-level social capital effects on health. Some of the literature points to smaller areas of aggregation (eg, neighborhoods) as important locations to observe health effects of social context. In addition, evidence suggests the mechanisms through which the health effects of poverty operate may be at a wider level of aggregation than the influence of social context: states may be satisfactory for economic indicators, but neighborhoods and communities may be a better choice of geographical area to study the health effects of social capital. Finally, the study is not able to examine both economic and social contextual factors simultaneously because of concerns regarding multicollinearity.

Future studies may address these limitations by using nationally representative data that are linkable to data sets expressly designed to study the effects of economic and social context on health for adolescents. The use of longitudinal designs would also be a critical component of investigating the social environment and adolescent development. Currently, there are no surveillance systems in place that include structural, contextual, developmental, and individual factors. In addition, investigations need to examine the moderating influences of gender and individual socioeconomic status on the effect of context on adolescent health behavior by stage.

CONCLUSIONS
Prevention efforts targeting adolescent risk behaviors have had inadequate success, partly because of the reliance on individual-level interventions that do not consider the context within which behavior occurs. Socially related origins of health disparities include social structural and social contextual influences that differentially affect certain groups. These forces place certain groups “at risk of risks.” In addition, there are collective community characteristics or features of social organization, such as social capital, which influence health and behavior possibly through their effects on psychosocial processes. Taken as a whole, the findings from this study point to the need for the inclusion of contextual-level data in surveillance systems assessing risk behavior in adolescents and consideration of the multilevel nature of the growing problem of inactivity and above-normal weight when focusing public health prevention efforts.

REFERENCES
A Multilevel Study of the Associations Between Economic and Social Context, Stage of Adolescence, and Physical Activity and Body Mass Index
Caroline Mae McKay, Bethany A. Bell-Ellison, Kirsten Wallace and John M. Ferron
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