

ARTICLE

A Multilevel Approach to Youth Physical Activity Research

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DUNCAN, S. C., T. E. DUNCAN, L. A. STRYCKER, and N. R. CHAUMETON. A multilevel approach to youth physical activity research. *Exerc. Sport Sci. Rev.*, Vol. 32, No. 3, pp. 95–99, 2004. *Social environment factors are hypothesized to interact with individual-level factors to influence youth physical activity. Multilevel analytic approaches are ideal for examining the influence of the social environment on youth physical activity as they allow examination of research questions across multiple contexts and levels (e.g., individual, family, and neighborhood levels).* **Keywords:** youth, physical activity, social environment, multilevel, family, neighborhood

INTRODUCTION

The past decade has witnessed increasing complexity in theoretical models attempting to explain physical activity involvement. Researchers have moved toward greater examination of the developmental nature of physical activity over time, person–environment interactions, and the social context as an interactive, interdependent network that exerts influence on all members.

In the domain of youth physical activity, it is hypothesized that social-level factors, such as those from family, peers, schools, and neighborhoods, interact with individual-level factors to determine physical activity behavior.

An individual-level variable is one that affects a single individual (e.g., gender, personal self-efficacy), whereas a social-level variable affects a group or cluster of individuals similarly (e.g., family income affects family, neighborhood recreational opportunities affect neighborhood residents, teacher behavior affects a class of students). When studying the effects of the social environment on youth physical activity, it is important to include potential influences at the appropriate level of the social hierarchy (e.g., individual-level covariates predicting individual-level variation in physical activity, family-level covariates predicting family-level variation, neighborhood factors included as predictors of neighborhood variation).

KEY WORK TO DATE

Social Cognitive Theory (1) and ecological models (2,12) specify that personal and environmental factors interact to influence health behavior. Personal and environmental factors influencing youth physical activity may include individual variables (e.g., self-efficacy), behavioral variables (e.g., diet and other health behaviors), and social and physical environmental variables (e.g., family support for physical activity, neighborhood safety, neighborhood park and recreation facilities). Despite increased recognition in recent years of the potentially important role of environmental factors on physical activity, as well as the potential interactive effects of these factors with other psychosocial variables (5,10,14), few studies have systematically examined the effects of environmental influences on youth physical activity.

Unfortunately, the physical activity literature typically has not distinguished environmental variables measured at the individual level from those measured at other levels of the social hierarchy (e.g., family, school, neighborhood, community). Individual-level measures include individuals' perceptions of their social environment (e.g., perceived neighborhood safety). They are not the same as environmental variables measured at the family, school, neighborhood, or community level (e.g., crime figures as an indicator of neighborhood safety). Multilevel variables such as these should be used in studies where research questions examine the behavior of groups or social clusters (e.g., individuals within families, schools, or neighborhoods) in addition to individual behavior. To date, few studies have systematically examined the effects of social contextual influences measured at multiple levels (e.g., family, school, neighborhood, and community) on youth physical activity.

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The family is one source of multiple environmental influences comprising an interactive, interdependent network in which the behavior of each individual modifies that of other individuals. Having a supportive family has consistently been associated with increased physical activity among youth (4). However, most of the research on family influences has been conducted at the individual level of analysis rather than as part of a multilevel study. A multilevel study of individuals and families includes determining homogeneity in physical activity among family members (the extent to which they are similar) and how appropriate level covariates influence the family's physical activity as a whole, as well as the youth individually.

Neighborhood influences rarely have been included in studies of youth physical activity, even though they represent a critical component of a comprehensive contextual model of youth and family physical activity (14). Much of the research on neighborhood influences on physical activity has focused on the physical environment (e.g., facilities) and almost exclusively among adults. For example, research has shown that neighborhoods rich in physical activity resources with easy accessibility may facilitate activity, whereas neighborhoods that lack resources or pose barriers may limit activity (5,11,14). The number and type of physical activity options, including structured physical activity programs and informal opportunities, such as parks, influence activity patterns of individuals and families. Resources, opportunity, convenience, and access to facilities and equipment all relate to participation in physical activity (9). Researchers studying physical activity have encouraged the examination of factors that may influence access to, or use of, facilities and programs within one's community and the development of integrative approaches across family and community to promote physical activity (9).

Fewer studies have examined the social aspects of the neighborhood environment or the effect of neighborhood influences of any kind specifically on youth physical activity. A few studies have begun to probe the effects of neighborhood social factors, such as social cohesion and collective efficacy, on physical activity behaviors and beliefs (5). Neighborhood collective efficacy is described as the link between mutual trust and a shared willingness to intervene for the common good of the neighborhood, based on elements of social control and social cohesion. This approach emphasizes shared beliefs in a neighborhood's capability for action to achieve an intended effect and assumes an active sense of engagement among neighborhood members (15).

USE OF APPROPRIATE ANALYSES FOR MULTILEVEL STUDIES

One reason for the lack of attention to social contextual factors in the past may have been the dearth of analytic techniques for dealing with clustered or multilevel data. Fortunately, such techniques now are widely available and include hierarchical linear modeling, structural equation modeling, latent growth modeling, and multilevel modeling.

When data are clustered or nested in some fashion (e.g., children in classrooms, individuals in a family, individuals or

families in a neighborhood), a multilevel structure exists. The aim of multilevel modeling is to analyze data simultaneously from different levels of the social hierarchy (e.g., repeated measures within individuals, individuals within families, families within neighborhoods). Multilevel modeling techniques offer researchers the opportunity to analyze data in a more technically appropriate manner compared with traditional single-level methods and to increase the complexity and contextual richness of research questions.

Multilevel analytic approaches, therefore, are ideal for examining the influence of the social environment on youth physical activity. Figure 1 depicts an example of a multilevel model of youth physical activity that simultaneously examines the physical activity of youth clustered within families and families clustered within neighborhoods, and the influence of covariates, such as demographic factors, individual beliefs (e.g., self-efficacy), family support and attitudes about physical activity, and neighborhood physical activity resources and opportunities.

Within the multilevel model depicted in Figure 1, each of the different levels in the hierarchical data structure (e.g., individuals, families, and neighborhoods) is represented by its own submodel, representing the structural relations and variability occurring at that level. In this case, the total variability in youth physical activity is broken down into its three components: level 1 within individual, level 2 among individuals within families, and level 3 among families within neighborhoods. This breakdown of effects allows the researcher to estimate the proportion of variation existing at each level of the hierarchy. The single-headed arrow from the family-level physical activity factor to the individual-level physical activity factor suggests that a proportion of the variability in the individual-level physical activity factor can be explained simply by knowing to what family an individual belongs. Similarly, a proportion of the variability in physical activity observed among families can be explained simply by knowing to what neighborhood a family belongs.

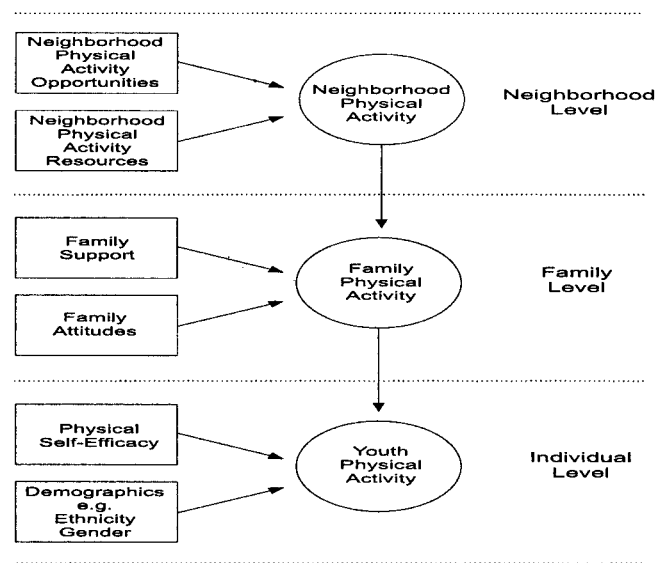


Figure 1. An example of a multilevel model to examine youth physical activity.

Within the structural component of the model, covariates can be included at each level of the hierarchy. Their influence does not vary across units within a given cluster, but varies across clusters. For example, the family-level covariate labeled “family support” influences each individual within a given family the same way (e.g., each family member has the same regression weight), but that influence varies across families. This family-level covariate also can be seen as influencing individual-level variation in youth physical activity indirectly through the family-level component of youth physical activity.

The potential for integrating typical structural equation modeling applications, and the features of the hierarchical, or random effects, model described above, make it possible to understand more precisely the influence of the social context on the development of physical activity through childhood and adolescence.

Preliminary findings from a federally funded longitudinal and multilevel study of youth physical activity are presented below.

A LONGITUDINAL MULTILEVEL STUDY OF YOUTH PHYSICAL ACTIVITY

Study Design and Sample Recruitment

A cohort-sequential design was used with recruitment of target males and females from 10-, 12-, and 14-yr-old cohorts. As can be seen in Figure 2, four annual assessments from these age cohorts yielded data representing the developmental range from 10 to 17 yrs of age. A quota system was set up for recruitment so that the final sample would consist of approximately equal numbers in each age group (10, 12, and 14 yrs), gender group, and neighborhood (58 neighbor-

hoods). The study design also necessitated recruitment balanced across seasons.

Youth were recruited primarily by telephone with some supplemental door-to-door recruitment. The project met its recruitment goal with a random stratified sample of 360 target youth and a parent of each child, nested in 58 different neighborhoods (4–8 families per neighborhood). A peer of each target youth also was invited to participate.

Assessments consisted of in-home surveys, completion of 7-d physical activity records and tracking steps for 1 wk with a pedometer supplied by the project. Participants were paid for their time. Data also were collected from numerous other sources. For more details about the design and sample recruitment, see Duncan *et al.* (7).

The study methods and recruitment procedures were designed to permit analyses of youth physical activity at multiple levels—individual, family, and neighborhood—using appropriate multilevel analyses. Preliminary studies examining the effect of social environment factors (family and neighborhood) on youth physical activity briefly are described below.

Examining Youth Physical Activity at the Family Level

Physical activity among family youth (siblings) was examined using hierarchical linear modeling (6). In typical studies of family physical activity, analyses have been conducted at the individual level, ignoring the dependence among family members. Analyses that fail to account for dependence among family members likely are biased in their results, because families serve as an important shared learning environment for enhancing health-related behaviors like physical activity. Hierarchical or multilevel analyses not only are more appropriate, but also advantageous. The hierarchical

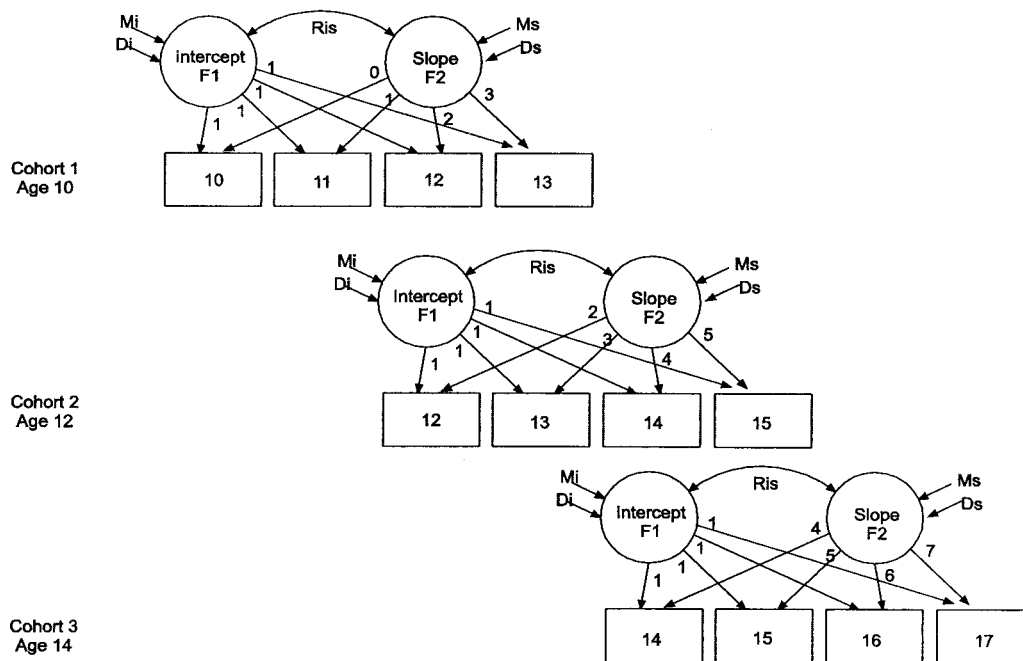


Figure 2. Representation of the cohort-sequential design for the youth physical activity study depicting the three age cohorts (ages 10, 12, and 14 yrs) and four annual assessments within an accelerated latent growth curve model.

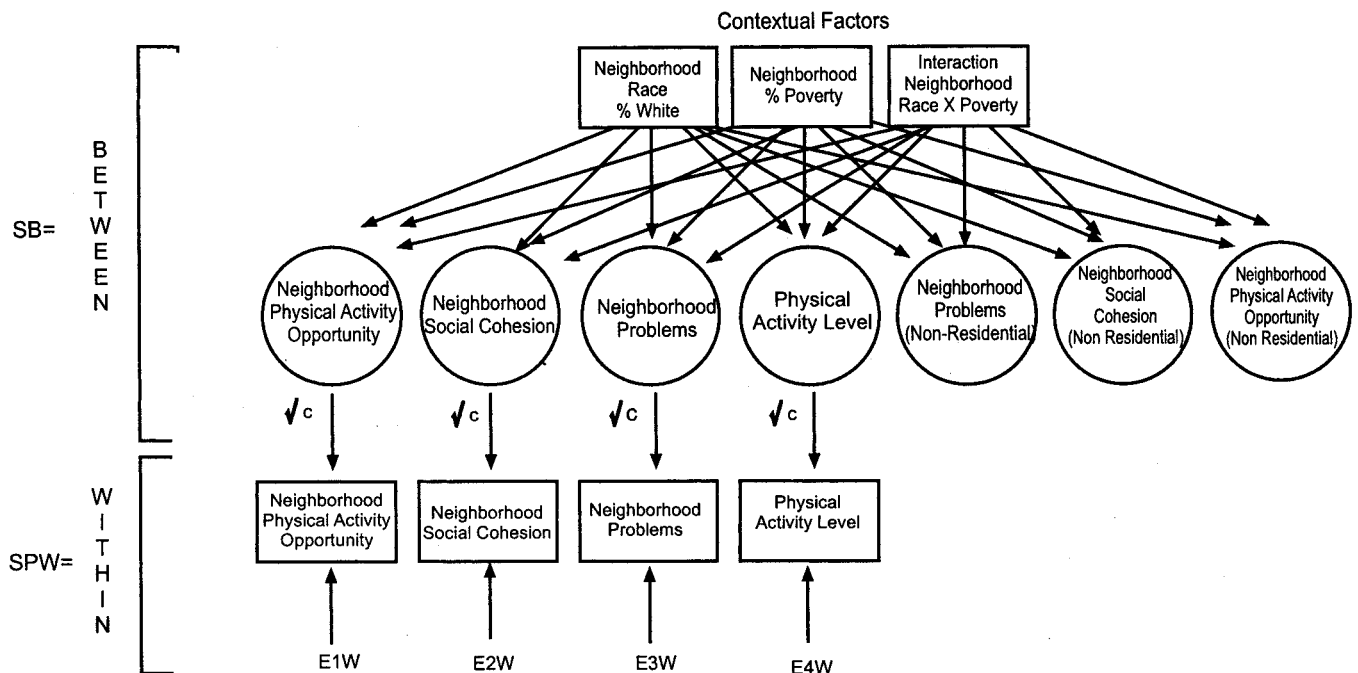


Figure 3. Multilevel neighborhood structural equation model showing the decomposition of individual-level variables into their within- and between-level variance components and the effects of social contextual variables on the between-level variables (*i.e.*, the nonresidential variables) and the between-level components of the individual-level variables.

analyses were designed to determine the extent of homogeneity in physical activity among siblings in a family, the extent of heterogeneity across families, and the relationship between hypothesized covariates of physical activity at the individual (*i.e.*, age, gender, and race) and family (*i.e.*, marital status, income, family support, perceived neighborhood recreational opportunities, and number of neighborhood physical activity facilities) levels of analysis. Results indicated that siblings had similar physical activity patterns and that activity varied across families. At the individual level, age was a significant predictor of physical activity. At the family level, higher levels of family support were related to greater levels of sibling physical activity, as were single-parent status and higher income. The findings suggest that interventions targeting families instead of simply individuals may yield more beneficial and enduring effects.

Examining Youth Physical Activity at the Neighborhood Level

Neighborhood attributes have the capacity to facilitate or hinder physical activity and may influence large populations. As such, they play an important role in influencing youth and adult physical activity. Although researchers recently have begun to study the effects of neighborhoods on physical activity behaviors and beliefs (14), few empirical studies at the neighborhood level have been conducted using appropriate multilevel statistical techniques.

We conducted a preliminary neighborhood-level study of physical activity using a multilevel design and multiple data sources (2). Depicted in Figure 3, the multilevel model examined the relations between neighborhood physical activity opportunity, neighborhood social cohesion, neighborhood problems, and individual (family members) levels of physical

activity. Relations were examined after controlling for the effects of neighborhood poverty and race. The results indicated significant homogeneity within and heterogeneity across neighborhoods on the variables of interest. Residents from the same neighborhood generally agreed in their assessments of physical activity opportunity, neighborhood social cohesion, and neighborhood problems, and perceptions of opportunities and social cohesion significantly were related to individual levels of physical activity. Moreover, these perceptions and relationships varied across neighborhoods.

The findings of this study and others suggest that physical activity interventions targeted at the neighborhood level—in addition to individual-, family-, and school-level programs—may be beneficial. Neighborhood interventions may focus on adding or improving physical activity facilities or environments, increasing awareness of existing facilities, identifying and publicizing available opportunities for physical activity, and tackling safety and crime issues (9).

CONCLUSIONS

Increasingly, social science researchers believe that physical activity is influenced by numerous social contexts such that social environment factors interact with individual-level factors to determine youth physical activity. However, few studies have examined systematically the effects of social contextual influences found within the family, peer groups, school, neighborhood, and community on youth physical activity (5,14).

The hypothesis that the social context influences youth physical activity is best studied within a multilevel design. Such a design necessitates the recruitment of a sample clustered or nested within different contexts (*e.g.*, individuals within fami-

lies, children within schools, individuals within neighborhoods, families within neighborhoods). Data should be collected at multiple levels and from multiple sources at each level, which enhances reliability and validity, and should be analyzed using appropriate multilevel or hierarchical data analytic techniques. This includes multilevel intervention studies designed to change family, school, and neighborhood and community social and physical environments (e.g., Lifestyle Education for Activity Program (3), Healthy Youth Places (8), The Middle-School Physical Activity and Nutrition Study (13)). Valuable studies such as these are encouraged to analyze data in a multilevel framework and to avoid analyzing multilevel indicators in a single level framework.

One of the advantages of multilevel or hierarchical modeling for examining environment influences on physical activity is that it allows the researcher to cluster the data at multiple levels, such as individuals within families or neighborhoods and families within neighborhoods, and to incorporate appropriate covariates at each of these levels. Preliminary studies presented here demonstrate the use of multilevel analyses for examining the homogeneity and heterogeneity in physical activity of siblings nested within families and in individuals nested within neighborhoods. Future analyses will include additional levels, such as youth within families and families within neighborhoods, and the use of longitudinal data to examine dynamic models of youth and family physical activity behavior.

Further research examining social contextual influences is needed to better understand physical activity among individuals of all ages. More studies are encouraged that examine physical activity at multiple levels, using multilevel analytic techniques that account for data dependence and clustering. Analyses such as these are likely to shed light on the influences of physical activity at different levels or within different contexts, which can inform the development of practical and effective interventions within different contexts and at multiple levels of the social hierarchy.

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