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RESEARCH ARTICLE

Neighborhood Environments and Physical Activity: A Longitudinal Study of Adolescents in a Natural Experiment

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Introduction: Experimental and quasi-experimental evidence on the relationship between adolescents' physical activity and their physical activity environments is scarce. This study provides natural experimental evidence using within-person longitudinal variation in physical activity environments resulting from the compulsory re-assignment of military families to new installations, termed *permanent changes of station*.

Methods: Adolescents in Army families (N=749) reported usual weekly minutes of moderate and vigorous physical activity in 2013–2015. Objective measures of the physical activity environment, including the number of fitness and recreation facilities within 2 miles, were constructed for adolescents' neighborhoods using GIS methods. In 2017, individual-level fixed-effects models with and without a comparison group estimated the relationship between usual weekly minutes of physical activity and physical activity environments among permanent changes of station movers using within-person variation.

Results: Increases in opportunities for physical activity were significantly and positively associated with increases in total ($p<0.05$) and vigorous physical activity ($p<0.05$) among adolescents who experienced permanent changes of station moves. The relationships were statistically significant for permanent changes of station movers living off-installation ($p<0.05$) and hence subject to greater variation in physical activity environments and those with more time to adjust to their new environments ($p<0.05$). Significant findings persisted when broader measures of physical activity environments were utilized.

Conclusions: The decline in physical activity and alarming obesity levels during adolescence suggest that this age may represent an important opportunity to address the obesity epidemic. This study provides evidence that increasing opportunities for physical activity may be an important pathway to improving their levels of physical activity and, consequently, obesity.

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INTRODUCTION

There has emerged a consensus among public health experts that changes in individual-level factors, such as genes, biology, and psychology, cannot explain the rapid rise in obesity over the past decades. Therefore, the explanation must involve broader environmental, policy, and societal factors that influence obesogenic behaviors.[1–7] Despite theoretical support for the hypothesis that improving opportunities for physical activity (PA) should increase PA levels,[8,9] estimating causal relationships has proved challenging because of difficulties in identifying exogenous variation in built environments.[10,11]

Because of the limited feasibility of randomized studies, the existing literature relied largely on observational studies using two sources of variation in the built

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environment. The first source was cross-sectional variation across locations where individuals live at a point in time. The second was longitudinal within-person variation generated by changes in their environments over time or by changes in their environments induced by moves. Both sources, however, were vulnerable to selection, which could bias estimates because individuals chose where to live, whether to continue living in a particular location, and how to influence their neighborhoods (e.g., supporting park initiatives). If those decisions were related to health preferences, behaviors, or outcomes, then relying on those sources of variation could bias estimates of the relationship between the built environment and PA, even in longitudinal analyses. For example, individuals who preferred to exercise outdoors might have chosen to live near a park, whereas those who developed a new interest in outdoor activities might have moved closer to those activities or supported efforts to foster opportunities for those activities in their current neighborhoods.

These concerns dominated recent literature reviews on how the built environment relates to obesogenic behaviors and outcomes.[12–14] Such reviews have pointed out the dearth of methodologically rigorous studies and called for natural experiments and quasi-experimental methods to advance this literature.[10,12,14] According to Mayne and colleagues,[15] only three experimental or quasi-experimental studies of PA and the built environment used the strongest research design of within-person longitudinal data with a comparison group. All three studies focused on the introduction of a new amenity (e.g., playground, trail, light rail) in a single city.[16–18] Importantly, none examined outcomes among adolescents, even though declines in PA during adolescence were well documented and obesity rates among adolescents were alarming.[19–21] A longitudinal study of PA among adolescents using non-experimental/non–quasi-experimental variation in PA environments among movers and non-movers yielded mixed results, perhaps because of selection concerns.[22]

This study addresses this critical gap by combining a unique natural experiment with longitudinal data on cohorts of treated and control adolescents. Specifically, the design leverages the relocation of military personnel, which generated unique variation in their PA environments. These moves, termed *permanent changes of station* (PCS), periodically reassign personnel to new installations based on the military's needs. Because PCS moves were based on the military's needs rather than their own or family preferences, they provided much-needed quasi-experimental variation in adolescents' environments. Support for the validity of this natural experiment to children's health outcomes has been documented,[23] and this study provides further analytic support. The sample includes adolescents in military families who experienced a PCS move during the observation period (PCS movers) and those that did not (non-movers). Importantly, all children were at risk of PCS: whether they experienced a PCS during the observation period was simply a matter of timing. Thus, the non-movers served as a natural control group.

The study's primary hypothesis is that adolescents increase their PA when they experience an increase in opportunities for fitness and recreation in their neighborhoods.

METHODS

Study Sample

The data were collected during the Military Teenagers Environment Exercise and Nutrition Study. The Military Teenagers Environment Exercise and Nutrition Study surveyed families of Army enlisted personnel with at least one dependent child aged 12–13 years (on March 31, 2013) located at ten large divisional posts and two medium-sized installations across all Census regions. Families were eligible to participate if: (1) the service member did not intend to leave the military within the coming year, (2) the child resided with the enlisted parent at least half-time, and (3) the child was enrolled in public or Department of Defense Education Activity schools.

Families were recruited, primarily online, between Spring 2013 and Summer 2014. Families recruited in 2013 were eligible to participate in two follow-up surveys in 2014 and 2015, whereas those recruited in 2014 were eligible to participate only in the 2015 follow-up. A total of 3,140 families completed the eligibility screener, 2,523 were eligible, 1,721 consented, and 1,519 completed at least one parent or child survey. Among these, 829 children provided longitudinal data for at least two waves and 749 were included in the analytic sample. The analytic sample excluded those with multiple PCS moves because of concerns that they would not have had sufficient time to respond to PA environments (n=9), those who moved within the 6 months prior to baseline to ensure that the baseline PA was sufficiently associated with PA environments (n=45), and those with international assignments because PA environment measures were not available (n=26). Although some children participated in three waves, the analytic sample included a balanced sample of two waves per child (hereafter, baseline and follow-up). The first two waves were retained unless later ones were adjacent to PCS moves. At baseline, the 749 families were distributed across 33 (rather than the original 12) installations because of relocations after personnel data were obtained and outdated personnel data.

The study was approved by the IRBs at RAND, University of Southern California, and the Army's Human Research Protection Office.

Measures

The primary outcome of interest is self-reported weekly minutes of PA. Similar to the National Health and Nutrition Examination Survey, children were asked about usual PA, including sports,

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