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| AUTORE: | Gregory W. Heath, Ross C. Brownson, Judy Kruger, Rebecca Miles, Kenneth E. Powell, Leigh T. Ramsey |
| COAUTORE: | the Task Force on Community Preventive Services |
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# The Effectiveness of Urban Design and Land Use and Transport Policies and Practices to Increase Physical Activity: A Systematic Review

**Gregory W. Heath, Ross C. Brownson, Judy Kruger, Rebecca Miles, Kenneth E. Powell, Leigh T. Ramsey, and the Task Force on Community Preventive Services**

*Background:* Although a number of environmental and policy interventions to promote physical activity are being widely used, there is sparse systematic information on the most effective approaches to guide population-wide interventions. *Methods:* We reviewed studies that addressed the following environmental and policy strategies to promote physical activity: community-scale urban design and land use policies and practices to increase physical activity; street-scale urban design and land use policies to increase physical activity; and transportation and travel policies and practices. These systematic reviews were based on the methods of the independent Task Force on Community Preventive Services. Exposure variables were classified according to the types of infrastructures/policies present in each study. Measures of physical activity behavior were used to assess effectiveness. *Results:* Two interventions were effective in promoting physical activity (community-scale and street-scale urban design and land use policies and practices). Additional information about applicability, other effects, and barriers to implementation are provided for these interventions. Evidence is insufficient to assess transportation policy and practices to promote physical activity. *Conclusions:* Because community- and street-scale urban design and land-use policies and practices met the Community Guide criteria for being effective physical activity interventions, implementing these policies and practices at the community-level should be a priority of public health practitioners and community decision makers.

***Key Words***: exercise, leisure activities, physical fitness, physical endurance, decision making, evidence-based medicine, economics, preventive health services, public health practice, meta-analysis, review literature, urban planning

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Heath is with the Dept of Health and Human Performance, University of Tennessee at Chattanooga. Brownson is with St. Louis University, School of Public Health, St. Louis, MO. Kruger and Ramsey are with the Division of Nutrition and Physical Activity, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA. Miles is with the Dept of Urban Planning, Florida State University, Tallahassee, FL. Powell is with the Epidemiology and Prevention Branch, Georgia Dept of Human Resources, Atlanta, GA. The names and affiliations of the Task Force members are listed at: www.thecommunityguide.org.

An estimated 200,000 to 300,000 premature deaths occur each year in the US due to physical inactivity.[1-2] Regular physical activity is associated with enhanced health and reduced risk for all-cause mortality.[3-6] Beyond the effects on mortality, physical activity has many health benefits, including reduced risk of cardiovascular disease,[7, 8] ischemic stroke,[9-11] non-insulin-dependent (type 2) diabetes,[12-15] colon cancers,[16-19] osteoporosis, [20-22] depression,[23-26] and fall-related injuries.[27-30] Despite the benefits of regular physical activity, only 45% of adults in the US report engaging in the recommended amounts of physical activity (i.e., 30 min of moderate-intensity activity on five or more days per week, or 20 min of vigorous-intensity activity on three or more days per week);[31] 29% report no leisure-time regular physical activity;[31] and only 27% of students (grades 9 through 12) engage in moderate-intensity physical activity (30 min, five or more days per week).[32] US trends in activity showed little improvement from 1990 to 1998.[33] Over 60% of the world's population is not physically active enough to achieve health benefits.[34] Colditz recently calculated the direct costs of inactivity, defined conservatively as absence of leisure-time physical activity, at approximately $24 billion or 2.4% of US health care expenditures.[35] Accordingly, the goal of increasing physical activity is one of ten "leading indicator" areas within the national health objectives of Healthy People 2010.[36]

Given this enormous health and economic burden, specific recommendations for promoting physical activity have emerged over the past several years. In part, this builds on the 1995 recommendation of the American College of Sports Medicine and the Centers for Disease Control and Prevention (CDC) that every adult in the US accumulate 30 min or more of moderate-intensity physical activity on most, preferably all, days of the week.[37] That same year, the US Preventive Services Task Force recommended that healthcare providers counsel all patients on the importance of incorporating physical activity into their daily routines.[38] In 2001 to 2002, recommendations for community-based efforts to promote physical activity were issued by the Task Force on Community Preventive Services[39] along with an evidence-based review. [40] Six recommended strategies for promoting physical activity in the community were distributed across three different physical activity promotion domains or approaches (Table 1). These domains included informational, behavioral and social, environmental and policy approaches to promoting physical activity. The substance of the initial evidence review covered two strategies from informational, four from behavioral and social, and one recommended intervention strategy from environmental and policy. The present review covers three environmental and policy approaches.

Environmental and policy approaches for the promotion of physical activity may be especially indicated as a complement to more frequently used individual behavior and lifestyle modification strategies because they can benefit all people exposed to the environment rather than focusing on changing the behavior of one person at a time.[41-46] Strategies often include providing access to facilities and programs that are not currently available to the population or supporting policy measures that favor activity. Examples of environmental and policy approaches to increase physical activity include: walking and bicycle trails, funding for public facilities, zoning and land use that facilitates activity in neighborhoods, building construction that encourages activity, and policies/incentives promoting physical activity during the workday.[41-46] Although such environmental and policy

**Table 1 Guide to Community Preventive Services Recommendations for Increasing Physical Activity in Communities**

| | |
|---|---|
| **Informational approaches to increasing physical activity** | |
| Community-wide campaigns | Strong evidence |
| "Point-of-decision"prompts | Sufficient evidence |
| **Behavioral and social approaches to increasing physical activity** | |
| Individually-adapted health behavior change | Strong evidence |
| School-based physical education | Strong evidence |
| Social Support in Community Settings | Strong evidence |
| **Environmental and policy approaches to increasing physical activity** | |
| Creation and/or enhanced access to places for PA combined with informational outreach activities | Strong evidence |
| Community-scale urban design/land-use policies and practices | Sufficient evidence |
| Street-scale urban design/land-use policies and practices | Sufficient evidence |

interventions to promote physical activity are being promoted widely,[43, 44] there is sparse systematic information on the most effective approaches for persons conducting population-wide interventions.[41-46]

Environmental and policy approaches are designed to provide environmental opportunities, support, and cues to help people develop healthier behaviors. The creation of healthful physical and organizational environments is attempted through development of policy that lends itself to creating supportive environments and strengthening community action. Correlation studies have shown that physical activity levels are associated with factors such as the availability of exercise equipment in the home and the proximity and density of places for physical activity within neighborhoods.[41] Additional studies suggest that neighborhood and environmental characteristics such as safety, lighting, weather, and air pollution are related to physical activity levels, regardless of individual motivation and knowledge.[44]

To affect entire populations, interventions in this category are not directed to individuals but rather to physical and organizational structures. The environmental and policy interventions are implemented and evaluated over a longer period of time than more individually-oriented interventions. Interventions can be conducted by traditional health professionals, but also involve many sectors whose practices are not driven by public health concerns, such as urban planners, transportation engineers, community agencies and organizations, legislators, and the mass media. The goal is to increase physical activity through changing social networks, organizational norms and policies, the physical environment, resources and facilities, and laws. Interventions reviewed here are 1) community-scale urban design and land use policies and practices to increase physical activity, 2) street-scale urban design and land use policies to increase physical activity, and 3) transportation and travel policies and practices.

# Methods

## The Guide to Community Preventive Services

The systematic reviews in this report are based on the methods of the independent, nonfederal Task Force on Community Preventive Services (the Task Force). The Task Force is developing the *Guide to Community Preventive Services* (the *Community Guide*) with the support of the US Department of Health and Human Services (DHHS) in collaboration with public and private partners. The Centers for Disease Control and Prevention (CDC) provides staff support to the Task Force for development of the *Community Guide*. A special supplement to the *American Journal of Preventive Medicine*, "Introducing the *Guide to Community Preventive Services*: Methods, First Recommendations and Expert Commentary," published in January 2000, presents the background and the methods used in developing the *Community Guide*.[47] The general methods used to conduct systematic reviews for the *Community Guide* have been described in detail elsewhere.[48-51] In brief, the current review was conducted by a diverse team representing a range of disciplines and backgrounds, including exercise science, health promotion, epidemiology, and urban design and planning. The team developed a conceptual framework for organizing, grouping, and selecting each of the environmental and policy interventions under consideration and for choosing the outcomes used to define success for each intervention. A systematic search for evidence was performed using standard computer-based search engines. The team searched beyond the traditional public health literature to include studies published in the urban design, planning, transportation, and architecture literatures; assessing the quality of and summarizing the strength of the body of evidence on effectiveness for each intervention; summarizing information about other evidence; and identifying a research agenda. In total, over 500 articles were examined for abstract content across the topic areas of urban design/land use and transportation. Each study that met the inclusion criteria was evaluated using a standardized abstraction form and was assessed for suitability of the study design and threats to validity. On the basis of the number of threats to validity, studies were characterized as having good, fair, or limited execution. Studies with limited execution were not included in the summary of the effect of the intervention. The remaining studies (i.e., those with good or fair execution) were considered qualifying studies. Estimates of effectiveness are based on those studies.

Net intervention effects were calculated for all reported measurements of a given outcome. Often, different variables were used within a study to assess changes affecting the same outcome (e.g., changes in physical activity might be calculated by measuring times per week in physical activity, self-reported physical activity score, minutes per week in physical activity, or all three). Multiple measurements of the same outcome were examined for consistency. Medians were calculated as summary effect measures for each type of measurement and were compared across outcomes for consistency.

Bodies of evidence of effectiveness were characterized as strong, sufficient, or insufficient on the basis of the number of available studies, the suitability of study designs for evaluating effectiveness, the quality of execution of the studies, the consistency of the results, and the effect size.

# Results

## Community-Scale Urban Design and Land Use Policies and Practices to Promote Physical Activity

Community-scale urban design and land-use regulations, policies, and practices commonly strive to create more livable communities. The interventions use policy instruments such as zoning regulations and building codes, and environmental changes brought about by government policies or builders' practices. The latter include policies encouraging transit-oriented development, and policies addressing street layouts, the density of development, the location of more stores, jobs and schools within walking distance of where people live. We restricted our review to those studies reporting physical activity outcomes, mostly walking or biking for transportation, but also total physical activity and outdoor active play.

The analytic framework used to evaluate effectiveness of community-scale urban design and land use regulations, policies, and practices to increase physical activity (Figure 1) illustrates the relationship between the built environment, funding availability, organizational support, and the mediating factors of greater numbers of people living within walking distance of shopping, work, and school; improved connectivity of streets and sidewalks; and preservation of or creation of green space and improved aesthetic qualities of the built environment. These effects in turn influence the overall amount of physical activity engaged in by residents of

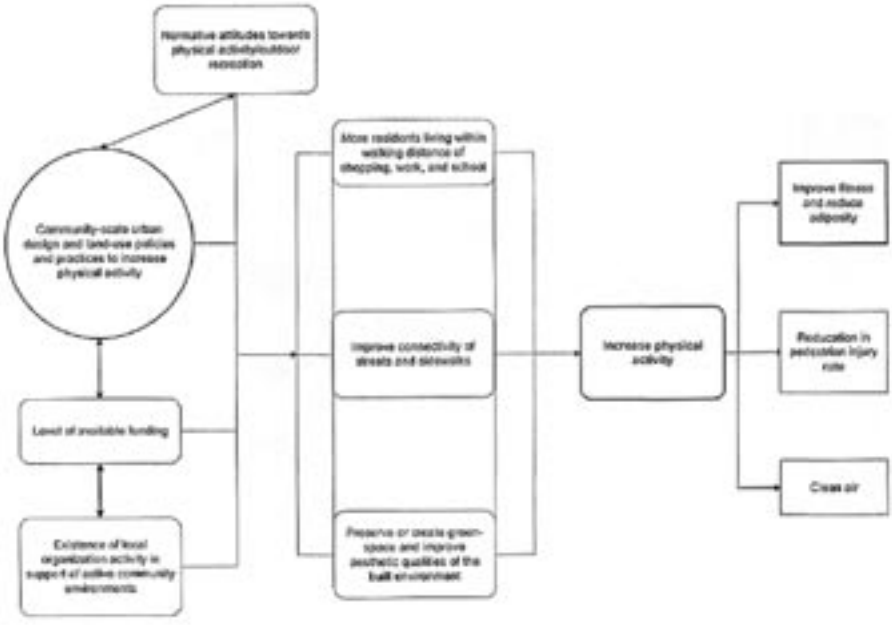


**Figure 1**—Logic model illustrating the analytic approach used reviewing the body of evidence for community-scale urban design/land use policies and practices to promote physical activity.

the community. For example, the level of funding available can affect urban design and land use regulations, policies and practices. In turn, these regulations, policies and practices may result in increased pedestrian safety, which may result in more people walking, improved fitness and reduced adiposity, reduction in pedestrian injuries, and cleaner air.

To evaluate the effectiveness of community-scale urban design and land use policies, and practices in promoting physical activity, we identified thirteen (13) studies from a pool of over 300 studies published during the years 1993-2003. [52-64] One study had limited quality of execution and was not included in our review.[64] Twelve (12) of the remaining studies had fair execution. The study designs were cross-sectional. [52-64] Details of the 12 qualifying studies are provided in Appendix A.

Reported behavioral outcomes and differences associated with each study are shown in Figure 2. These differences are reported by variable measures for each study and include change in pedestrians per hour per 1000 residents, percent change in pedestrians per 1000 housing units, percent trips, and distance and duration of the trip. Although we did not attempt a single quantitative summary across the diverse effect measures, the results of the various effect measures support a generally similar narrative conclusion: the preponderance of the evidence suggests that this type of intervention is associated with higher levels of physical activity.

The weakness of this body of evidence is that the outcome measures of physical activity were often incomplete; the studies were all cross-sectional, raising the specter of selection bias, and limited the outcomes to behavioral differences rather than behavioral change. In addition, the community-scale studies' exposures were

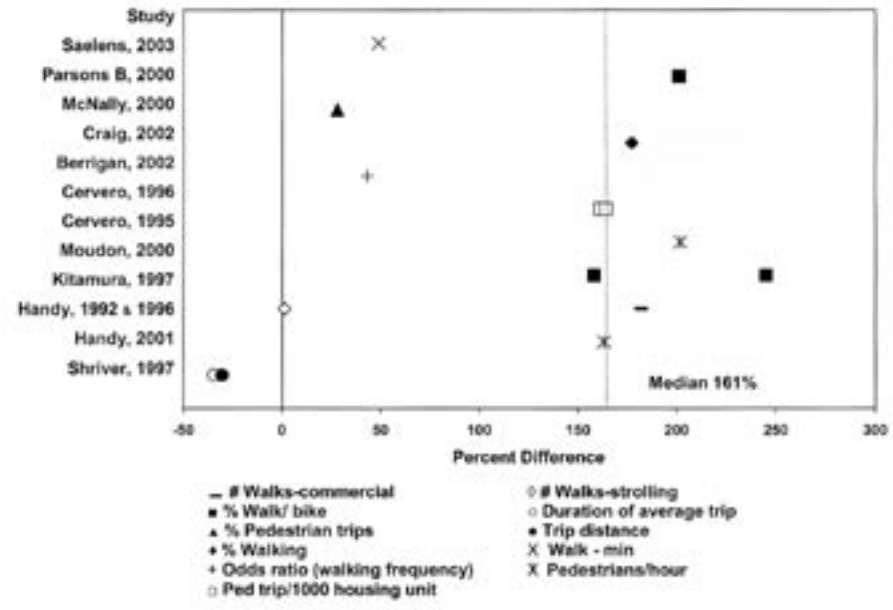


**Figure 2**—Community-scale urban design/land use polices and practices to promote physical activity: net percentage change for each of the effectiveness measures from baseline in frequency of physical activity.

grouped, making it difficult to know what characteristics of the built environment are important.

Regarding self selection, recent work by Schawnen and Mokhtarian[65] have suggested that people's beliefs about the impact of automobile use on the environment are more important in explaining the variation in distance traveled by automobile and rail than their attitudes about land use configurations. For walking/bicycling/jogging behaviors the affective feelings or liking for walking were more relevant to decisions about usage and distance covered than about land use configurations as well. These results suggest that the differences in walking and bicycling seen among residents living in contrasting community settings (i.e., well connected mixed-use vs. isolated suburban communities) are less likely due to pre-decisions by activity-oriented residents to live in a more well connected community than the presence of increased opportunities afforded by the built environment to be more physically active. (See Research Issues)

The body of evidence used to evaluate the applicability of this intervention was the same as that used to evaluate the effectiveness. Twelve studies were conducted in the US,[52-54, 56-64] and one study in Canada.[55] Four studies compared communities with grid/rectilinear street design with communities with cul-de-sac street design.[53, 54, 56, 61, 64] Three studies compared pedestrian friendly environments (e.g., ease of crossing street, topography, continuity of sidewalks, etc.) with non-pedestrian friendly environments.[59, 60, 62]

Among these studies the intervention and comparison communities were similar in terms of socioeconomic status (SES) and racial/ethnic parameters. In addition, within as well as between studies, there was a range of SES. Given the diversity of populations included in this body of evidence, these results should be applicable to diverse settings and populations, provided appropriate attention is paid to adapting the intervention to the target population. Given that the studies reviewed were carried out in urban to suburban environments, it is unclear whether the same components of design and land use apply to rural settings, although many of the design features illustrated in this body of evidence can be found in small towns/cities located in rural regions.

The systematic review development team identified potential barriers to implementation of community-scale urban design and land use regulations, policies, and practices. These barriers include 1) changing how cities are built given that the urban landscape changes relatively slowly, 2) zoning regulations that preclude mixed-use neighborhoods, 3) cost of remodeling/retrofitting existing communities, 4) lack of effective communication between different professional groups (i.e., urban planners, architects, transportation engineers, public health professionals, etc.), and 5) changing behavioral norms directed towards urban design, lifestyle, and physical activity patterns.

According to the Community Guide rules of evidence,[47] sufficient evidence shows that community-scale urban design and land use regulations, policies, and practices can be effective in increasing walking and bicycling. The regulations, policies, and practices that do so provide places people need or want to visit such as retail or commercial establishments or places of employment close enough to be reached by methods other than driving, and safe and attractive pathways to get there. Mixed land use (e.g., proximate residential and commercial areas) and sidewalk quality and connectivity are specific examples of helpful practices.

## Street-Scale Urban Design and Land Use Policies and Practices to Increase Physical Activity

Street-scale urban design and land use approaches use policy instruments and practices to support physical activity in small geographic areas, generally limited to a few blocks. These policies and practices include features such as improved street lighting or infrastructure projects that increase the ease and safety of street crossing, ensure sidewalk continuity, introduce or enhance traffic calming such as center islands or raised crosswalks, or enhance the aesthetics of the street area, such as landscaping. We restricted our review to those studies reporting physical activity (walking, bicycling, and outdoor play) outcomes.

These interventions involved the efforts of urban planners, architects, engineers, developers, and public health professionals who were instrumental in creating or providing more safe, secure, and enjoyable streets and sidewalks for walking and biking. For example, interventions in the body of evidence included adding bicycle lanes and assessing the effect of the perceived environment. In addition to promoting access, improved aesthetics and safety from both traffic and crime were important aspects of these interventions.

Our search identified a total of six studies derived from a pool of over 100 articles published during the years 1987 to 2003[66-71] evaluating the effectiveness of street-scale urban design and land use policies to support physical activity in small geographic areas, generally limited to a few blocks. All studies were of moderate suitability,[47] and consisted of quasi-experimental pre-post or cross-sectional study design. All studies were of fair execution and were included in the body of evidence. Effectiveness measures reported in this body of evidence varied across the studies and are expressed as 1) change or difference in the percentage of people walking, 2) change or difference in the number of people active, and 3) change or difference in the number of walkers, path users, or cyclists (see Figure 4). Overall, the median increase in physical activity across the effect measures was 35% (inter-quartile range: 16% to 62%). Details of the six qualifying studies are provided in Appendix B.

These interventions were designed to enhance the urban environment and/or to increase physical activity by redesigning streets and sidewalks and improving the perceived environment. The specific interventions varied among the qualifying studies, precluding the identification of specific components in common. However, the interventions all involved issues related to access, aesthetics, and safety. Improved street lighting and traffic calming measures are specific examples of the types of intervention strategies in this group of studies.

The body of evidence used to evaluate the applicability of this intervention was the same as that used to evaluate the effectiveness. One study each was conducted in the US,[71] Australia,[66] Belgium,[67] Canada,[69] England,[70] and Germany.[68] The interventions in this review were relighting streets,[70] redesigning streets,[68, 69] and improving street aesthetics.[66, 67] One study stratified for males and females.[67] This type of intervention is likely to be applicable across diverse settings and population groups, provided appropriate attention is paid to adapting the intervention to the specific setting and target population.

One potential barrier to street-scale urban design and land use policies is the expense of changing existing streetscapes. In addition, street-scale urban design and

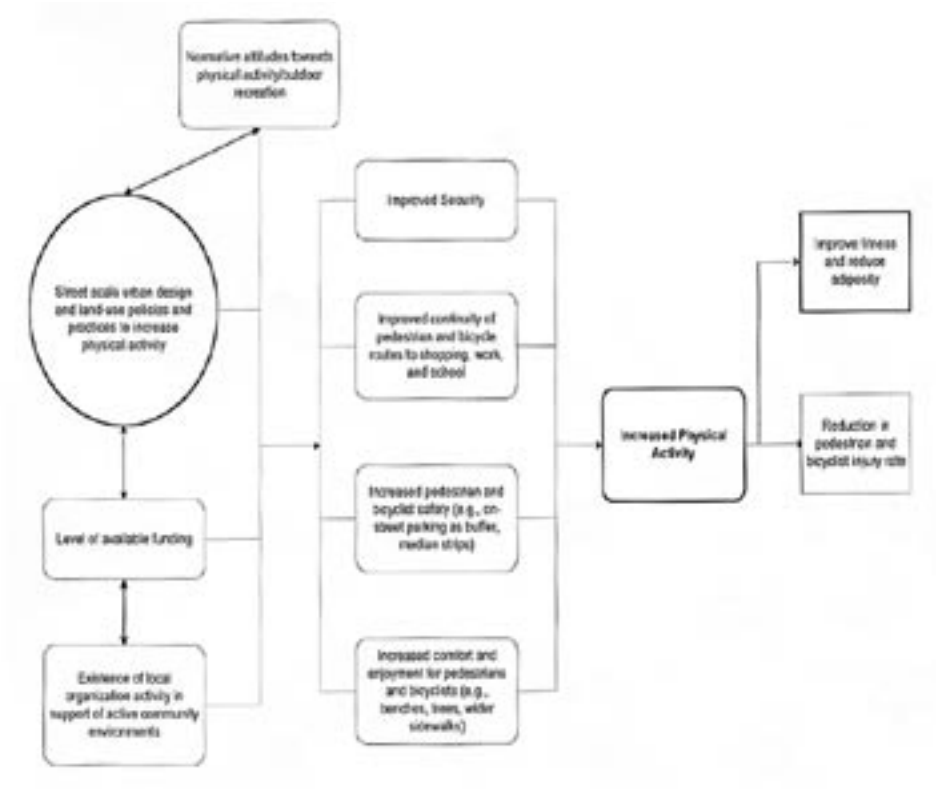


**Figure 3**—Logic model illustrating the analytic approach used reviewing the body of evidence for street-scale urban design/land use policies and practices to promote physical activity.

land use policies require careful planning and coordination between urban planners, architects, engineers, developers, and public health professionals. Success is greatly enhanced by community buy-in, which can take time and effort to achieve. Inadequate resources and lack of incentives for improving pedestrian-friendliness may affect how completely and appropriately interventions are implemented and evaluated.

According to *Community Guide* rules of evidence,[47] there is sufficient evidence that street-scale urban design and land use policies to support physical activity in small geographic areas, generally limited to a few blocks, is effective in increasing levels of physical activity. The regulations, policies, and practices that do so provide safer and more aesthetic places people need or want to visit close enough to be reached by active transport. Redesigned streets (e.g., creating/renovating playgrounds, forming squares, one-way streets, traffic calming, and bicycle lanes), improved lighting, and enhanced aesthetics are specific examples of helpful practices, as measured by an increase in the percentage of people engaging in active transport or other measures of physical activity.

## Transportation and Travel Policies and Practices

Transportation/travel interventions of interest to promoting physical activity include interventions that strive to improve pedestrian, transit and light rail access, increase pedestrian and cyclist activity and safety, reduce car use, and improve air quality. We restricted our review to those studies reporting physical activity (walking or bicycling) outcomes.

The interventions used policy and environmental changes such as creating and/or enhancing bike lanes, requiring sidewalks, subsidizing transit passes, providing incentives to car or van pool, increasing the cost of parking, and adding bicycle racks on buses.

Our search identified three studies out of over 90 identified studies from the years 1990 to 1998[72-74] evaluating the effectiveness of transportation and travel policies and practices. Of these, two studies had limited quality of execution and were not included in our review.[72, 74] The remaining study had fair execution. The study design was time series.[73]

The effectiveness measures was mode choice for walking to school.[73]

Evidence about barriers to implementation of this intervention was not collected because effectiveness was not established.

According to the Community Guide rules of evidence,[47] available studies provided insufficient evidence to determine effectiveness of transportation and travel policy and practice interventions in increasing physical activity or improving fitness, because of an insufficient number of studies.

## Research Issues

The effectiveness of recommended interventions in this section (i.e., community-scale urban design and land use policies and street-scale urban design and land use policies) is established. However, several crosscutting research issues about the effectiveness of all the reviewed interventions remain. These are organized under the headings of measurement, urban design and land use characteristics, and interaction between the social and physical environment.

### *Measurement*

- What are the relationships between "objective" (e.g., derived by community and street-scale audits) and "perceived" (e.g., derived by telephone survey) neighborhood characteristics and does this relationship vary by perceived preference?
- How can future studies detect how close one's perception is to reality of the environment and what methods would best improve our understanding of this difference?
- In terms of an organizational structure, how should the built environment be conceptualized and what is the best way to measure or quantify components of the built environment (e.g., accessibility, aesthetics, safety, walkability)?
- What are the key findings of future studies that rely on "objective" measures of physical activity, as derived from motion sensors?

- What is the optimal method for collecting self-reported data on physical activity and do those vary by domain (e.g., recreational vs. transport activity)?
- How can new studies incorporate data at the individual level, rather than the trip level?
- How can existing GIS-derived data be used to improve the measurement abilities of future studies?
- How can surveillance for physical activity policies be conducted (national vs. state vs. local) and can they be related to patterns of behavior?
- How best can we design longitudinal studies that account for the temporal sequence between "exposure" to the environment and behavior change?
- How can new studies best determine the effects of re-location (e.g., using "reasons for moving" scales, measuring attitudes)?
- Will larger studies with better measurement allow us to better describe the specific characteristics of the urban environment that are most conducive for physical activity?

### *Urban Design and Land Use Characteristics*

- What is the geographic scale(s) at which the neighborhood environment is most strongly correlated with physical activity?
- What are differences in the effectiveness of urban practices and policies, based on whether they are macro-level changes or micro-level changes (e.g., zoning changes in a community vs. adding street lights or sidewalks)?
- How do these interventions apply in less populated or rural areas?
- What characteristics of the built environment (e.g., land use mix, walkability, bike paths, improved street lighting, ease and safety of street crossing, sidewalk continuity, landscaping) best facilitate physical activity?
- What effect does urban redevelopment have on physical activity levels of inner city residents?

### *Interaction of the Social and Physical Environment*

- Do injury rates increase or decrease as a result of these intervention strategies?
- What leads to effective collaboration across sectors as communities seek to promote physical activity?
- Can new studies be conducted that assess the potential interaction of effects between the physical and social environments?
- Does multivariate adjustment for potential confounding factors (e.g., age, income, gender) change the relationship between the built environment, policies, and physical activity? If so, what potential confounders are most important?
- Is it possible to use existing data to assess the impact of selection bias (e.g., stratifying data sets by income group)?

- What factors lead to an enhanced likelihood that policies friendly toward physical activity will be enacted and enforced?
- Among elected officials, what are the key drivers in moving forward an agenda that supports activity-friendly communities?
- How best can the various sectors (e.g., public health professionals, urban planners, travel behavior researchers) collaborate to implement policies and practices that promote activity?
- Does the built environment have similar effects on PA among the majority population, among diverse racial/ethnic, low SES, and various age and ability groups?
- How well does perceived safety from crime coincide with objective measures of safety from crime? What explains any observed differences? How important are they in influencing physical activity? How should physical activity interventions address erroneous perceptions of safety from crime?
- How much of an impact do these recommended strategies have on the likelihood of pedestrian and bicyclist injuries? Are there additional infrastructural adaptations necessary to enhance pedestrian and cyclist traffic safety?

The availability of economic data was limited. Therefore, considerable research is warranted on the following questions:

- What is the cost-effectiveness of each of these interventions and how can it be increased?
- How can effectiveness in terms of health outcomes or quality-adjusted health outcomes be better measured, estimated, or modeled?
- How can the cost-benefit of these programs be estimated?
- Does making cities more walkable improve economic development?

## Translating Community Guide Recommendations for Increasing Physical Activity into Public Health Action

The challenges in translating scientific information into meaningful public health programs and policies are substantial. The recommendations described in this article provide science-based guidance on environmental and policy interventions to promote physical activity. However, the recommendations alone provide relatively little information on *how* to implement effective interventions. Similarly, a recent review of this topic by a combined committee of the Transportation Research Board (TRB) and the Institute of Medicine (IOM) concluded that the built environment "can facilitate or constrain physical activity" and recommended that "those responsible for modifications to the built environment should facilitate access, enhance the attractiveness of, and ensure the safety and security of places where people can be physically active." The committee did not, however, recommend

any specific changes because the causal evidence supporting any specific change or changes is not yet available.[75]

There are a number of practical issues that should be considered when implementing the recommendations of the *Community Guide*. First, the local context for an intervention should be assessed in conjunction with the information in the *Community Guide*. This is important because decisions in public health are based on a number of factors including scientific effectiveness, available resources, community priorities, perceived value, and culture.[76,77] It is important to keep in mind that intervention effectiveness does not necessarily equate with intervention feasibility. For example, before addressing any new intervention program or policy, it may be crucial to conduct a local needs assessment—this may involve both qualitative and quantitative data. In addition, practitioners may benefit from a variety of ready-made tools for program planning, implementation, and evaluation. The purpose of these tools is to provide resources on how to best implement an intervention after a potentially effective program has been chosen from the menu in the *Guide*.

## Conclusion

The *Community Guide's* physical activity recommendations identify intervention tools that practitioners can use to achieve the Healthy People 2010 Objectives for Physical Activity and Fitness.[36] The Task Force recommends with strong evidence the creation of and enhanced access to places for physical activity combined with informational outreach activities. Recommended with sufficient evidence are community-scale and street-scale urban design and land use policies and practices to promote physical activity. These set of recommendations point out the roles that policy and environmental approaches to increasing physical activity can play in combating inactivity in our culture. These recommendations should serve well the needs of researchers, planners, community leaders, and other public health decision makers in shaping the future agenda for efforts to explore and promote physical activity and thereby improve the health of the nation.

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## Appendix A Intervention: Community-scale Urban Design (form)/land-use

| Author & year<br>Design suitability<br>Quality of execution | Intervention and comparison elements | Study population description<br>Sample size | Results<br>Effect measure | Value used in summary | FU time |
|---|---|---|---|---|---|
| Shriver K, 1997<br><br>Least: cross-sectional<br><br>Moderate execution | Location: Austin, TX (Hyde Park and Clarksville (traditional) and Barton Hills and Wells Branch (modern)<br>Components: Traditional – grid street design, office sites within walking distance, shorter building setbacks or porches with outdoor seating modern discontinuous streets and cul-de-sacs, walking distance between houses and commercial services greater than average, homes setback from street and 60% more off street parking<br>Comparison: modern neighborhood (cul-de-sac, discontinuous streets) and traditional neighborhoods (connections and direct routes) | | (I-C)/C<br>C = modern | Distance of average trip: -34.5%<br>Duration of average trip: -30.4%<br><br>Average trip distance and duration are less in traditional neighborhoods, but a greater proportion of trips are for errands and commuting than in modern neighborhoods | none |
| Handy SL, 2001<br><br>Least: cross sectional<br><br>Fair execution | Location: 6 middle-income neighborhoods in Austin, TX<br>Components: Environmental factors of 6 communities were characterized by 3 factors. Individuals in each community were surveyed on their behavior and usage of local stores. Distance from home to local stores was calculated<br>Comparison: To determine if location of local shopping opportunities reduces automobile dependence and to determine residents choice to walk vs. drive to local shopping | Traditional ((Old West Austin ($n$ = 281) and Travis Heights ($n$ =245)); Early modern (Cherrywood $n$ = 226) and Zilker ($n$ = 220)); Late modern ((Wells Branch ($n$ = 204) and Tanglewood ($n$ = 192)) | Walking mode for shopping<br><br>(I –C) / C x 100<br><br>C = early mod or late mod<br>I = Trad | Traditional vs. Early mod<br>10.5% - 4% / 4% x 100 = 163% NIE<br><br>Traditional vs. Late mod<br>10.5%-4%/4% x 100 = 163% NIE<br>NIE = net intervention effect | none |
| Handy SL, 1992 and 1996<br><br>Least: cross sectional<br><br>Fair execution | Location: Santa Clara and Santa Rosa, CA<br>Components: local accessibility if being near a activity, such as convenience good, supermarkets and drug stores, and located in small enters<br>Comparison: modern/low local accessibility and traditional/high local accessibility | | (I – C)/C<br><br>C = Sunnyvale, Rincon Valley - modern/ low accessibility<br>I = Mountain View and Junior College – traditional/ high accessibility | Walk/stroll to local shopping mall 181.8%<br>% walking to shopping center monthly 48.6%<br>Walks/strolls last month 1.2%<br>% strolling at least monthly 4.5% | none |

| Author & year<br>Design suitability<br>Quality of execution | Intervention and comparison elements | Study population description<br>Sample size | Results<br>Effect measure | Value used in summary | FU time |
|---|---|---|---|---|---|
| Cervero, 1995<br><br>Least: cross-sectional<br><br>Fair execution | Location: Los Angeles Area, CA; San Francisco Bay area, CA<br><br>Components: transit neighborhood built along streetcar line or around a rail station, primarily grid design, largely built before 1945<br>Auto neighborhood laid out without regard to transit, > 50% intersections, 3-way or cul-de-sacs, built after 1945<br>Comparison: Transit and Auto neighborhood | Los Angeles – 6 match paired neighborhoods<br><br>San Francisco – 7 match paired neighborhoods | (I – C)/C<br><br>C = auto neighborhood<br>I = transit neighborhood | % difference in proportion of pedestrian trips and in pedestrian trips per 1000 housing units Los Angeles area, CA<br>pedestrian trips 161%<br>pedestrian rates/1000 housing units 163 (Without Claremont<br>pedestrian trips 38%<br>pedestrian rates/1000 housing units 109%<br>Calculated without Claremont because college and large number of students on or near campus increases<br>pedestrian rate<br>San Francisco Bay Area, CA<br>% pedestrian trips 183<br>pedestrian rates/1000 housing units 164 | none |
| Berrigan D, 2002<br><br>Least: cross sectional<br><br>Fair execution | NHANES III survey which is a national stratified multi-stage probability design. *N* = 17,030 adults responded to household and family survey questions, however, only *N* = 14,827 respondents responded to behavioral and demographic variables used in this paper<br><br>Home age is a measure of urban form because it is associated with density, street design, building characteristics. Neighborhoods containing older homes in urban areas are more likely to have sidewalks, have denser interconnected networks of streets and often display a mix of business and residential uses<br>Setting: National survey<br>Delivery: NHANES III | Population description:<br>% Male – 48<br>% White – 77.7<br>% AA – 10.1<br>% Hispanic – 4.8<br>% Other – 7.3<br>% Age 20-39 – 45.5<br>% Age 40-59 – 31.4<br>% Age > 60 – 23.1<br>% < High school – 23.4<br>% High school – 33.7<br>% Any college – 42.9<br>% SES < $20,000 – 31.7<br>% SES > $20,000 – 68.3<br>% Activity limitation yes – 15.7 | Odds ratios calculated for differences in walking by home age, comparing urban vs. suburban<br><br>Age of home:<br>> = 1974, 1946-1973 and < 1946 | OR for walking frequency comparing :<br>> = 1974 vs. 1946-1973 home age = 1.44 (unadj) 1.36 (adj)<br>> = 1974 vs. < 1946 home age = 1.44 (unadj) 1.43 (adj)<br>Net intervention effect % walking 1 mile without stopping<br>Home built post 1973 (OR = 1.0) vs. home built pre 1946 (OR = 1.43) = 43% | |

*(continued)*

## Appendix A *(continued)*

| Author & year<br>Design suitability<br>Quality of execution | Intervention and comparison elements | Study population description<br>Sample size | Results<br>Effect measure | Value used in summary | FU time |
|---|---|---|---|---|---|
| Parsons – Brinckerhoff, 1993<br>Least: cross-sectional<br>Fair execution | Location: Portland, OR – 400 zones<br>Components: Pedestrian Environment Factor (ease of street crossing, sidewalk continuity, local street characteristics, topography) each zone is scored<br>Comparison: PEF, pedestrian zone, household density | 5000 households in random zones | (PEF9-12)-(PEF 4-8))/ PEF 4-8 | Mode of choice walk/bike<br>PEF 4-8 vs 9-12 201%<br>Zones with higher PEF (9-12) made 3x as many transit trips and 4x as many walk bike trips<br>Ped zone cat – more ped friendly the environment the greater the proportion of trips made by walking/biking<br>Zonal density 0-3 vs 3- >5 163%<br>less dense zones generate more auto trips<br>transit level of service<br>0 – 120,000 vs > 120,000 182% | NA |
| Saelens BE, 2003<br>Least: cross sectional<br>Fair execution | *N* = 107; 54 –high walkability neighborhood – 53 low walkability neighborhood<br>Eligibility: communities selected on basis of walkability and comparable on the basis of age of residents, SES of residents<br>Comparison: cross sectional assessment among persons living in two different built environments regarding walking behavior and other physical activity | Population description:<br>High walk Low walk<br>% F 51.9 54.7<br>% W 79.6 83.0<br>% L 13.0 5.7<br>% B 0.0 1.9<br>% other 3.7 3.7<br>Ed/C 63.0 41.5<br>Age 44.9 50.8 | (I-C)/C<br>I = High walk<br>C = Low walk | Walking and total PA by neighborhood<br>CSA measures : Walk avg min/ day<br>195-131/131 x 100 = 48.9% NIE<br>Total PA avg min/day<br>211-140/140 x 100 = 50.7% NIE | |

## Appendix B Intervention: Street-scale Urban-design (form) / land use

| Author & year<br>Design suitability<br>Quality of execution | Intervention and comparison elements | Study population description<br>Sample size | Results | | |
|---|---|---|---|---|---|
| | | | Effect measure | Value used in summary | FU time |
| Painter K, 1996<br><br>Least: before-after<br><br>Fair execution | Location: Metropolitan London, England (Edmonton, Tower Hamlets, Hammersmith and Fulham)<br><br>Components: identified poorly lit areas and improved the lighting<br><br>Comparison: before and after improved lighting | | (Post-Pre)/Pre | Edmonton<br>% change in # of persons using footpath<br>Male 50%<br>Female 64%<br>% change in # persons walking<br>Male 44%<br>Female 45%<br>Tower Hamlets - % change persons walking<br>Male 34%<br>Female 48%<br>Hammersmith and Fulham - % change persons walking<br>Male 101%<br>Female 71%%<br>Total avg net effect % change in persons walking 51% | 6 wk |
| MacBeth AG, 1999<br><br>Least: before-after<br><br>Fair execution | Location: 6 streets in Toronto, Canada<br><br>Components: Promoted biking, converted 4 lane roads to 2 lane roads with biking and parking, narrowed streets, planted trees<br><br>Comparison: pre and post | Bicyclists | (Post-Pre)/Pre | Bicycle traffic 23% | Approx 2 y |

*(continued)*

## Appendix B *(continued)*

| Author & year<br>Design suitability<br>Quality of execution | Intervention and comparison elements | Study population description<br>Sample size | Results | | |
|---|---|---|---|---|---|
| | | | Effect measure | Value used in summary | FU time |
| DeBourdeaudhuij I, 2001<br><br>Least: Cross-sectional<br><br>Fair execution | Location: Ghent, Belgium<br><br>Components: Identified neighborhood and recreational environmental variables correlated with physical activity (walking, moderate activity, vigorous activity)<br>Comparison: cross sectional/correlational | Study population: Random sample of 1000 Ghent residents<br>*N* = 521 | (Post-Pre)/Pre | Significant correlates for walking by gender:<br>Men (*n* = 252)<br>Availability of sidewalks *r* = 0.14*<br>Women (*n* = 269)<br>Land use mix (density) *r* = 0.15*<br>Ease of walking to public transp. *r* = 0.16*<br>Significant correlates for moderate activity by gender: Women (*n* = 269)<br>Land use mix (access to local shopping) *r* = 0.16* | none |
| Ball K, 2001<br><br>Least: Cross-sectional<br><br>Fair execution | Location: NSW, Australia<br><br>Components: Perceived environmental aesthetics, convenience, companion walking behavior (walking and non-walking)<br><br>Comparison: cross sectional | Study population: Random sample from electronic white pages directory of NSW residents<br>*N* = 3392 | (I-C)/C<br><br>Environmental aesthetics (friendly, attractive, neighborhood, pleasant to walk)<br>I = High aesthetics<br>C = Low aesthetics<br><br>Environmental convenience (shops in walking distance, parks in walking distance, access to cycling path)<br>I = High convenience<br>C = Low convenience | Environmental aesthetics (OR & 95%CI & *P*-value)<br>Aesthetics high 1.00<br>Aesthetics moderate 0.84 (0.71-0.99) < 0.01<br>Aesthetics low 0.59 (0.47-0.75) < 0.01<br><br>Net intervention effect<br>High (1.00) vs. Low (0.59) = 70%<br><br>Environmental convenience (OR & 95%CI & *P*-value)<br>Convenience high 1.00<br>Convenience moderate 0.84 (0.71-1.00) < 0.01<br>Convenience low 0.64 (0.54-0.77) < 0.01<br><br>Net intervention effect<br>High (1.00) vs. Low (0.64) = 56% | none |