Journal of Urban Health: Bulletin of the New York Academy of Medicine, Vol. 83, No. 3
doi:10.1007/s11524-005-9017-2

A Method for Observing Physical Activity on Residential Sidewalks and Streets

Richard R. Suminski, Rick L. Petosa, and Emily Stevens

ABSTRACT *Assessment of physical activity needs to improve in order to gain a more comprehensive understanding of the relationship between characteristics of the environment and physical activity. Our study evaluated a method [Block Walk Method (BWM)] for observing physical activity along residential sidewalks and streets. The BWM was utilized in 12 U.S. Census block groups over a three-month period. Examination transportation routes (ETRs), 1,524 m in length, were constructed and examined in each block group. On 6 days, ETRs were traversed by a trained observer for 50 min. Physical activities, street names, and geographical locations (e.g., addresses) were recorded. We found encouraging results for the BWM. The level of agreement between independent observers was >98% for activity type. The number of individuals seen walking, running, or biking did not differ significantly between the days of the week or observation times. The number of individuals observed was correlated with block group characteristics (e.g., percent walking/biking to work) and weather (e.g., temperature). The BWM is an easy to use, economically viable observational approach to obtaining reliable information concerning physical activities performed on residential streets and sidewalks. Its use could help advance our understanding about the environment–physical activity relationship.*

KEYWORDS *Behavior assessment, Exercise, Measurement*

INTRODUCTION

Overweight and obesity rates continue to rise in the U.S., contributing to approximately 400,000 deaths per year.[1,2] Besides the risk of morbidity and mortality, medical expenses related to the treatment of obesity have been shown to account for as much as 9.1% of total U.S. medical expenditures or approximately $92.6 billion in 2002 dollars.[2,3]

Increasing rates of obesity have been attributed, in part, to environmental changes that directly and indirectly reduce obligatory and leisure-time physical activity.[4] Inadequate and inconvenient physical activity opportunities, unsafe conditions, heavy traffic, and auto-orientated neighborhood planning schemes have all been shown to negatively impact physical activity.[5–9]

These findings have led to strong recommendations to implement approaches targeting environmental/policy changes.[10] However, such recommendations may

Suminski is with the School of Physical Activity and Educational Services, The Ohio State University, 155 Cunz Hall, Columbus, OH 43210, USA; Petosa and Stevens are with the School of Physical Activity and Educational Services, The Ohio State University, Columbus, OH 43026, USA.

Correspondence: Richard Richard Suminski, PhD, MPH, School of Physical Activity and Educational Services, The Ohio State University, 155 Cunz Hall, Columbus, OH 43210, USA. (E-mail: suminski.1@osu.edu)

be premature. Most studies examining environment–physical activity relationships have relied primarily on self-report questionnaires to measure physical activity. Several authors have documented the problems associated with physical activity questionnaires (modest validity, large overestimations, recall bias).[11–13] Another limitation is the lack of a valid approach for determining the extent a physical activity is actually performed in an environment being investigated. Previous studies either asked subjects where they did an activity or assumed activities were preformed in a particular location (e.g., around the subjects home).[5,7–9]

Clearly, improved methods for measuring physical activity are needed to advance our understanding of environment–physical activity relationships. Observation methodology may be a viable approach. The method is valid and reliable, sensitive to changes in physical activity patterns, applicable to diverse groups, administratively feasible, and it does not affect the behavior being studied.[14] Environmental characteristics have been shown to explain substantial proportions (42–59%) of the variance in physical activity when physical activity was assessed with an observation method.[15] Therefore, the purpose of this study was to develop and evaluate a method for observing physical activities occurring on residential sidewalks and streets [Block Walk Method (BWM)].

MATERIALS AND METHODS

Geographical Areas Studied

A total of 12 U.S. Census block groups from four, U.S. Census tracts (three per tract) were selected for observation. The block groups were located in an urban area, with a high population density (>8 residential dwelling per residential acre) and a grid pattern street design.[16] The total length of transportation routes (i.e., streets and/or sidewalks) in residential areas of the block groups ranged in length from 2,306 to 2,808 m (Mean ± SD = 2,583 ± 168.0 m). The streets in the block groups ranged in width from 6.5 to 18.3 m (Mean = 8.6 m), and the sidewalks were 1.0 to 1.9 m (Mean = 1.48 m) in width. Residential buildings constituted over 98% of the structures along the transportation routes. All length and width measures were obtained using a computer mapping program (ArcView 9.0, Environmental Systems Research Institute, Inc., California). Detailed block group characteristics based on U.S. Census aggregated data are presented in Table 1.[17]

Block Walk Method

Examination Transportation Routes (ETRs) Examination transportation routes consisting of five 305-m segments were constructed in each block group (Fig. 1). The start point of a segment was always located within 15 m of the end point of the preceding segment. The ETRs contained between 48.1 and 85.2% of all residential households and between 52.3 and 84.1% of the total transportation route length in the residential areas of a given block group.

Observation Periods Each ETR was observed on four weekdays and two weekend days. Two observation days occurred in May, two in June and two in July. For each observation day, one 50-min observation period was utilized. The weekday observation periods were between 4–5, 5–6, 6–7, and 7–8 P.M. The weekend

TABLE 1. U.S. census block group characteristics (n = 12)

	Mean	SD	Minimum	Maximum
Median family income (1999 U.S. $)	39,899	8,344	29,236	53,056
Median home value (1999 U.S. $)	118,766	29,135	78,000	161,900
Block group population	756	208	572	1123
Housing units	383	91.1	288	557
% in labor force	79.8	5.7	68.0	88.0
% of labor force working ≥35 h/wk	65.8	5.1	59.0	74.0
% of labor force working 15–34 h/wk	15.8	5.2	8.0	22.0
% of labor force working 0 to 14 h/wk	18.5	6.6	5.0	32.0
% walking or biking to work	5.7	3.9	0.00	11.4
% income: poverty level ratio ≥2.0	75.0	14.1	47.0	94.0
% of homes built 1939 or before	52.1	14.2	35.0	78.0
% with no vehicle	7.8	4.6	2.0	17.0
% with a high school degree or less	21.4	5.0	15.2	30.8
% with a bachelors degree or higher	36.0	9.8	20.4	56.6
% manual labor occupations	7.0	4.9	1.0	18.0
Temperature (°C)	21.9	5.2	3.3	28.9
% Humidity	56.4	15.9	31.0	88.5
Barometric pressure (mb/hg)	29.9	0.1	29.6	30.4
Average wind speed (mph)	9.6	5.1	0.0	23.0
Rain (mm)	0.3	0.8	0.0	5.1

observation periods were between 1–2 and 3–4 P.M. The first observation day, observation period and starting segment were chosen at random. A counter-balanced design was used to create the remaining schedule.

During an observation period, a trained observer traversed an ETR at a pace of 30.5 m/min. A battery powered metronome was used to regulate the walking pace at 50, 2-ft (0.61 m) steps per minute (largo). At the end of each segment, observers where allotted 2 min to prepare for the next segment. Therefore, during a 1-h period, an ETR was observed for 50 min (10 min/segment). It should be noted that when an observer encountered a street that intersected a segment (see Fig. 1, segment 5) they ceased observations, crossed the street, and then resumed observations. Therefore, the width of the streets crossed did not constitute a part of the 305-m segments. This was done for safety reasons.

Observation Field The observation field was defined as a line extending to the left and right of the observer's shoulders, linear and perpendicular from the observer's plane of motion. The observation fields ranged in width from 9.1–21.3 m and included the opposite sidewalk from the ETR, the street aligned with the ETR, and the sidewalk used by the observer (Fig. 2). Observers recorded selected physical activities (walking, biking, running, and walking a dog) that occurred in the observation fields. A physical activity was only recorded if the observer crossed a parallel plane of motion to an observed physical activity; therefore, the observer had to cross paths with the physically active person in order for them to be counted.

Recording Instrument An observation recording instrument was developed specifically for the procedure so the observer could record the physical activity observed, the street name where the activity occurred, nearest address to the activity, and the number of individuals engaged in the activity. Content evidence

FIGURE 1. Example of an examination transportation route in block group × (S# denotes start of a route and E# signifies the end of a route).

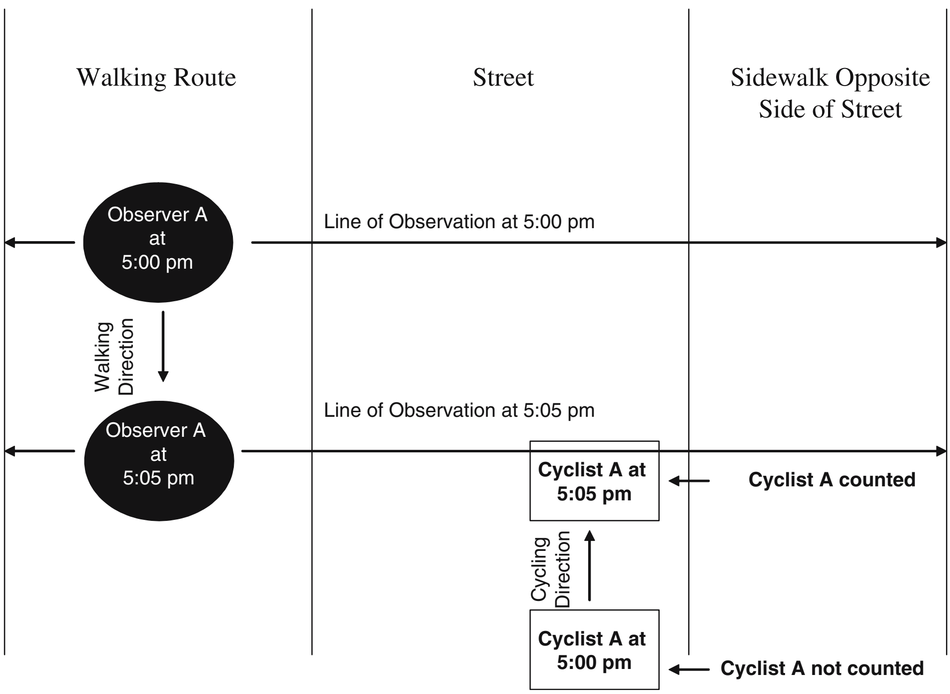

FIGURE 2. Schematic representation of the observation procedure: counting a cyclist.

validity for the instrument was established a priori through a two-stage expert panel review. The instruments contained information specific to each ETR including detailed walking directions and a map.

Observer Training Two weeks prior to the start of data collection, each of the four observers completed 5 h of training. They were trained on how to identify an observation, follow the ETR at a pace of 30.5 m/min, and use the recording instrument. The first sessions was conducted in a classroom in order to convey verbal instructions on the procedure. During the second session, observers practiced walking (with the aide of a metronome) at the required pace in a hallway. For the final session, mock observations were conducted in the field.

Weather Conditions Data on weather conditions (e.g., rainfall, relative humidity) was obtained from the meteorology department at a local university. The weather data corresponded with the exact time of day an observation period occurred.

Statistical Analyses

Inter-observer reliability was calculated as the level of agreement between two independent observers traversing the same ETR during the same observation period. Six different observation days were used for this procedure to accommodate four observers. Agreement between observers was checked for the type of physical activity observed (e.g., walking), the address assigned to the observed activity, and the number of individuals involved in the observed activity. Analysis of Variance (ANOVA) was used to determine if the number of individuals observed for each of the activities differed between days of the week or observation periods. Pearson product moment correlation coefficients were calculated to examine relationships between block group characteristics, weather conditions and the number of individuals observed for each activity. All analyses were conducted using SPSS version 12.0, with alpha set a priori at 0.05.

RESULTS

The levels of agreement for physical activity type were 97.8% for walking, 98.0% for running, 99.1% for biking, and 100% for walking with a dog. For the number of individuals counted, the levels of agreement were 98.6% for walking, 98.2% for running, 99.4% for biking, and 100% for waking with a dog. The address assigned to a recorded activity was agreed upon 88.1% of the time. Observers agreed on all three elements (physical activity type, location, and number of individuals) 97.7% of the time.

Descriptive information for observed physical activities is given in Table 2 for the 12 block groups combined. A total of 538 individuals were seen during the 72, 50-min observation periods. Walking was the most common activity observed followed by biking, walking a dog, and running. Walkers (without a dog) accounted for 59.1% of all individuals observed. There was considerable variation in the number of individuals observed between block groups. For example, the number of walkers seen ranged from eight to 41 and the number of bikers ranged from three to 22.

TABLE 2. Number of individuals observed performing physical activities along the examination transportation routes (*n* = 12 block groups)

	Mean	SD	Minimum	Maximum	Total
Biking	9.8	5.0	3.0	22.0	118
Running	3.8	3.7	0.0	14.0	45
Walking	26.5	9.7	8.0	41.0	318
Dog Walking	4.8	3.6	1.0	11.0	57

The number of individuals observed walking, biking, running or walking a dog did not differ between the six observation periods ($F(4, 360) = 0.7$; $p = 0.6$) or the seven days of the week ($F(5,360) = 1.1$; $p = 0.4$). The interaction term (days*times) was not significant ($F(8,360) = 1.3$; $p = 0.2$). The number of individuals seen walking was positively correlated with the percent of homes built before 1940 (Table 3). There were fewer runners observed as the percent of residents walking/biking to work increased and the percent of residents in the labor force increased. More individuals were observed walking a dog if there were more housing units and residents in a block group. The number of individuals seen biking was positively correlated with the percent of residents walking/biking to work. Weather conditions during the observation periods were related with the number of individuals observed. Fewer individuals were seen walking when the barometric pressure was high, more individuals were observed biking and walking a dog when

TABLE 3. Correlations between block group characteristics and physical activity

	Walking	Running	Biking	Dog walking
Median family income (1999 U.S. $)	−0.35	0.32	0.22	0.51
Median home value (1999 U.S. $)	−0.45	0.04	−0.02	0.23
Block group population	−0.20	−0.06	−0.08	0.72**
Housing units	−0.39	−0.08	−0.13	0.68*
% in labor force	−0.10	−0.84***	0.21	−0.26
% of labor force working ≥35 h/wk	−0.28	−0.49	−0.19	−0.04
% of labor force working 15–34 h/wk	0.26	−0.41	0.04	0.05
% of labor force working 0 to 14 h/wk	0.01	0.70*	0.12	−0.01
% walking or biking to work	0.05	−0.60*	0.62*	−0.23
% income: poverty level ratio ≥2.0	−0.32	0.03	−0.21	0.09
% of homes built 1939 or before	0.58*	0.01	−0.49	−0.03
% with no vehicle	0.01	0.04	0.36	−0.07
% with a high school degree or less	0.41	−0.06	−0.37	−0.41
% with a bachelors degree or higher	−0.01	0.08	0.22	0.14
% manual labor occupations	0.14	−0.10	0.09	−0.28
Temperature (°C)	−0.03	0.04	0.36*	0.33*
Humidity	0.13	0.07	0.18	0.08
Barometric pressure (mb/hg)	−0.24[a]	−0.18	−0.18	0.18
Wind speed (mph)	0.05	−0.26	0.33*	−0.09
Rain (mm)	−0.07	0.17	−0.14	−0.06

*$p < 0.05$.
**$p > 0.01$.
***$p < 0.001$.

temperatures were higher and more bikers were seen when wind speeds were higher.

DISCUSSION

The results of this study indicate that observation methodology can be used to obtain reliable information on physical activities as they occur on residential sidewalks and streets. Research in this area has been limited because of an inability to obtain representative samples, discern the location of the activity, and realistically utilize existing technology.[13,16]

Previous studies did not assess behaviors and environmental conditions simultaneously. This is the basis of momentary ecological assessment, and it has been stressed as a distinct advantage of the observation method.[18] The BWM method can be used to describe the environmental (social and physical) context in which a behavior occurred. For example, the number of individuals walking along a particular section of transportation route could be determined at the same time traffic speed and volume is assessed. The condition of the walking route (e.g., wet) or the presence of other individuals could also be ascertained while assessing activities.

Another unique aspect of the BWM is the ability to pinpoint activities and environmental conditions to a specific geographical location (e.g., address). This could not be done in past studies which could only describe environmental conditions in the general vicinity of where subjects lived or where subjects said they did the activity.[16,19–22] The BWM can be used to gather valuable information for exploring spatial relationships using geographical information systems (GIS) technology. Although the levels of agreement for the address where an activity was observed were acceptable, they were lower than for activity type and number. Following a debriefing of the observers and close examination of the address data, a few reasons were found for the inconsistencies. Some activities were observed between addresses or at points not in front of a house. In these two situations, the "nearest" address to where the activity occurred had to be decided upon by the observer. Observer error (writing down a similar but wrong address, 247 vs. 427) was also a reason for disagreement between observers.

The BWM method uses a mobile observer who samples points along a predetermined route at precise times. Previously developed observation methods employed a stationary observer for a defined area (e.g., gym).[23,24] Both approaches allow simultaneous assessments of environmental conditions and activity. However, because of the mobile observer, the BWM method can be used to assess large areas (1,524-m-long transportation route) that couldn't be viewed from only one vantage point.

The results suggest that the use of residential sidewalks and streets for walking, biking, and running is fairly consistent across the days of the week and at different times of the day. These findings should be interpreted with caution because only a few time periods were sampled. Activity levels could be higher or lower during other time periods. In addition, weather conditions, which were stable and mild during most of the observation periods, were associated with the number of individuals observed. Overall the effects of weather were minimized due to the use of several observation days and the relatively mild and similar weather conditions encountered on most of the observation days. However, weather should be a major consideration for future applications of the BWM method, especially if it is extreme or considerably variable during observations or if only a few observation periods are utilized.

Some of the characteristics of the population residing in the block groups were associated with the activities observed. Similar to findings reported by others, the correlation profiles varied by activity type.[21,25] More walkers were seen in block groups having older homes, which may be a proxy for features of the urban environment that influence walking behavior.[26] Fewer runners were observed in block groups with more residents walking/biking to work and more residents in the labor force. However, as the percentage of residents in the labor force working less than 14 h/wk increased, so did the number of runners observed. It may be that running is replaced by other exercises (biking to work) or working (i.e., hours worked) may be a barrier to performing an exercise such as running.[27]

Limitations of this study should be considered when interpreting the results and designing future research paradigms. The BWM method was developed and examined in urban, residential neighborhoods with similar designs (e.g., grid street patterns). It is possible that the technique cannot be used in different types of neighborhoods (e.g., suburban, highly populated). Another limitation was the use of block group-level data instead of direct measures of environmental conditions. Direct measures of the physical environment should be made and correlated with activity accessed with the BWM. Finally, the BWM cannot be used to track individual behavior, discern the reason (exercise or transportation) an activity is being performed, or account for activities occurring in places such as homes and gyms. Therefore, it is recommended that to obtain a complete profile of a community's physical activity patterns, numerous approaches to measuring physical activity should be employed (e.g., conducting surveys, observing additional areas, etc).

In conclusion, the BWM method provides reliable information concerning the number of individuals walking, biking, and running on residential streets and sidewalks. The use of observers is one of several approaches to doing more objective assessments of physical activity on a community-wide scale. Efforts are being made to develop objective measures to monitor mass walking behaviors, for example, the placement of sensing devices along trails or the use of video cameras for monitoring designated areas. It is possible that these methods can be used in conjunction with the BWM to obtain a comprehensive profile of a community's physical activity patterns and identify environments that promote or restrict physical activity.

ACKNOWLEDGEMENT

Funding for this study was provided by The Centers for Disease Control and Prevention (RO6/CCR521805).

REFERENCES

1. Flegal KM, Carroll MD, Ogden CL, Johnson CL. Prevalence and trends in obesity among US adults, 1999–2000. *JAMA*. 2002;288:1723–1727.
2. Mokdad AH, Marks JS, Stroup DF, Gerberding JL. Actual causes of death in the United States, 2000. *JAMA*. 2004;291:1238–1245.
3. Finkelstein EA, Fiebelkorn IC, Wang G. National medical spending attributable to overweight and obesity: how much, and who's paying? *Health Aff*. 2003;W3;219–226.

4. Hill JO, Peters JC. Environmental contributions to the obesity epidemic. *Science*. 1998;280:1371–1374.
5. Sallis JF, Bauman A, Pratt M. Environmental and policy interventions to promote physical activity. *Am J Prev Med*. 1998;15:379–397.
6. Sallis JF, McKenzie TL, Elder JP, Broyles SL, Nader PR. Factors parents use in selecting play spaces for young children. *Arch Pediatr Adolesc Med*. 1997;151:414–427.
7. Troped PJ, Saunders RP, Pate RR, Reininger B, Ureda JR, Thompson SJ. Associations between self-reported and objective physical environmental factors and use of a community rail-trail. *Prev Med*. 2001;32:191–200.
8. Frank LD, Pivo G. Impacts of mixed use and density on utilization of three modes of travel: single-occupant vehicle, transit, and walking. *Transp Res Rec*. 1995;1466:44–52.
9. Replogle M. Integrating pedestrian and bicycle factors into regional transportation planning models: summary of state-of-the-art and suggested steps forward. Environmental Defense Fund Report, Washington, DC; July 20, 1995.
10. U.S. Department of Health, Guide to Community Preventive Services: Systematic Reviews and Evidence-Based Recommendations. Increasing Physical Activity: A Report on Recommendations of the Task Force on Community Preventive Services. MMWR Vol. 50/No. RR-18, October 26, 2001.
11. Pereira MA, Fitzgerald SJ, Gregg EW, et al. A collection of physical activity questionnaires for health-related research. *Med Sci Sports Exerc*. 1997;29:S1–S205.
12. Washburn RA, Heath GW, Jackson AW. Reliability and validity issues concerning large-scale surveillance of physical activity. *Res Q Exerc Sport*. 2000;71:104–113.
13. Sallis JF, Saelens BE. Assessment of physical activity by self-report: status, limitations and future directions. *Res Q for Exerc Sport*. 2000;71:1–14.
14. Blair SN, Haskell WL, Ho P, et al. Assessment of habitual physical activity by a seven-day recall in a community survey controlled experiment. *Am J Epidemiol*. 1985;122: 794–804.
15. Sallis JF, Conway TL, Prochaska JJ, McKenzie TL, Marshall SJ, Brown M. The association of school environments with youth physical activity. *Am J Public Health*. 2001;91:618–620.
16. Frank LD, Schmid TL, Sallis JF, Chapman J, Saelens BE. Linking objectively measured physical activity with objectively measured urban form: findings from the SMARTRAQ. *Am J Prev Med*. 2005;28:117–125.
17. US Census Bureau. American Fact Finder. Census 2000 Summary File 3 (SF 3)-Sample Data. Retrieved January 22, 2005 from: http://factfinder.census.gov; 2000.
18. McKenzie TL. Use of direct observation to assess physical activity. In: Welk GJ, ed. *Physical Activity Assessments for Health Related Research*. Champaign, IL: Human Kinetics; 2002:179–195.
19. Hoehner CM, Brennam Ramirez LK, Elliott MB, Handy SL, Brownson RC. Perceived and objective environmental measures and physical activity among urban adults. *Am J Prev Med*. 2005;28:105–116.
20. Saelens BE, Sallis JF, Black JB, Chen D. Neighborhood-based differences in physical activity: an environment scale evaluation. *Am J Public Health*. 2003;93:1552–1558.
21. Suminski RR, Poston WS, Petosa RL, Stevens E, Katzenmoyer LM. Features of the neighborhood environment and walking by U.S. adults. *Am J Prev Med*. 2005;28:149–155.
22. Giles-Corti B, Broomhall MH, Knuiman M, et al. Increasing walking how important is distance to, attractiveness, and size of public open spaces? *Am J Prev Med*. 2005;28: 169–176.
23. McKenzie TL, Sallis JF, Nader PR, et al. BEACHES: an observational system for assessing children's eating and physical activity behaviors and associated events. *J Appl Behav Anal*. 1991;24(1):141–151.
24. McKenzie TL, Marshall SJ, Sallis JF, Conway TL. Leisure-time physical activity in school environments: an observational study using SOPLAY. *Prev Med*. 2000;30:70–77.
25. Humpel N, Marshall AL, Leslie E, Bauman A, Owen N. Changes in neighborhood

walking are related to changes in perceptions of environmental attributes. *Ann Behav Med*. 2004:27:60–67.
26. Berrigan D, Troiano RP. The association between urban form and physical activity in U.S. adults. *Am J Prev Med*. 2002;23(2 Suppl):74–79.
27. Fleury J, Lee SM, Matteson B, Belyea M. Barriers to physical activity maintenance after cardiac rehabilitation. *J Cardiopulm Rehabil*. 2004;24:296–305.