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The Use of Geocaching as a Form of Physical Activity in Youth

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ABSTRACT

Background: In order to promote physical activity among youth, it is critical that communities offer options beyond sports that still provide similar health benefits. **Purpose**: Given the appeal of technology among today's youth, the purpose of our study was to evaluate geocaching as a technology-based platform for promoting physical activity in youth. **Methods**: High school youth ($N = 31$) participated in 2 separate activity sessions, walking and geocaching. Accelerometers were worn and questions concerning perceived exertion and enjoyment were addressed at both sessions. **Results**: Although repeated measures t tests ($P < .05$) revealed no significant differences between activity sessions, each session yielded approximately 60 minutes of physical activity in a relatively inactive sample of youth. Additionally, the youth from the study reported that both walking and geocaching were enjoyable and relatively easy activities. **Discussion**: Results from this study do not suggest that geocaching would lead to greater activity levels than walking. Rather, geocaching was found to promote activity levels similar to walking. **Translation to Health Education Practice**: Given its use of technology and its application of challenge, geocaching may instead generate more interest than walking, leading to an increased interest among youth and, ultimately, an associated potential for additional physical activity.

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Background

Childhood obesity continues to be a concern in the United States; 32% of children and youth aged 2–19 years are either obese or overweight.[1] Factors related to obesity and overweight include, but are not limited to, diet and physical inactivity. With respect to youth, of particular concern are not only the declining rates of physical activity participation but also the increasing amount of time spent in sedentary activities.[2-4] Nonetheless, the benefits of being physically active are considered as a preventative measure to other chronic conditions (eg, hypertension, cardiovascular disease, metabolic disorders) that are increasing in this young age group.[5,6] Thus, encouraging youth to participate in any type of physical activity is critical to impacting overall health.

Physical activity recommendations for youth in the United States include participation in at least 60 minutes daily.[6] However, evidence from the Centers for Disease Control and Prevention[7] indicates that less than 16% of adolescents actually met these requirements. One suggestion regarding the lack of physical activity participation is that opportunities for youth to engage in the recommended 60 minutes of physical activity a day appear to be increasingly limited.[6] There are at least 2 possible explanations for this. First, adolescents spend a considerable amount of their day in school, with limited time allocated for being active. In addition to being in school, it has been shown that students in the United States spend as much as 6–8 hours a day being sedentary.[4] Second, there has been a decline in required physical education in high schools.[8,9] For example, specific to the United States, though lower grade levels often have mandated requirements for daily physical activity opportunities in either physical education or recess, high schools may now only require one year of physical education.[9] Together, these factors lead to the need for encouraging youth to be physically active outside of the school day and providing them with opportunities for activities other than sports.[10]

Finding activities that will engage today's youth and decrease sedentary time is becoming increasingly important. The extensive amount of time youth spend playing video games suggests that technology-based mediua that promote physical activity may be viable options because they already reach a great number of diverse youth and are perceived as highly enjoyable by this age group.[11,12] As a result, technology-based

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outdoor activities may have an advantage in attracting and retaining the attention of adolescents.[13] Given the prevalence of smartphones within a family unit, applications that can be downloaded to a smartphone and used to promote physical activity (eg, exergames) may provide youth with increased opportunities to be physically active. For example, Bolous and Yang[14] reported exergames with Global Positioning System (GPS) ability were intrinsically motivating to youth. In addition, they concluded that exergames involving searching, using maps, and finding treasures would not only motivate youth to be active but engage them in the activity, ultimately promoting their overall development.

One smartphone GPS-based application that has found to be valuable with youth and adults worldwide is geocaching.[14,15] Geocaching, a "high tech treasure hunt," combines technology (eg, GPS) with physical activity (eg, walking) and therefore may be well designed to appeal to youth. Geocaching can be done using either a GPS receiver or an app on a smartphone. It requires the participant to locate a treasure or "cache" that is placed in a particular area using GPS coordinates. Caches are basically the "treasures" and can range from a small toy or trinket to a log book. In some cases, the item in the cache can be taken and replaced with a different object. Often caches are not out in the open, meaning that they have to be searched for, which can be part of the fun; they are hidden enough that a beginner can find them. In order to find a cache, the participant obtains the GPS coordinates located on Geocaching website (www.geocaching.com) and navigates to the cache using the coordinates and clues provided. Attempting to locate the cache is what adds an element of challenge. The caches can be found in cities or towns and on greenways, parks, or hiking trails. Finding caches can be one way to explore an area and engage its participants in physical activity. Thus, it is anticipated that geocaching may be of interest to youth because it is an outdoor activity[16] that utilizes technology and is challenging and fun, both of which have been suggested to be important elements for youth participation.[13,16,17]

Purpose

In order to complete a geocaching activity, individuals are provided coordinates that are entered into a GPS device, as well as written clues to assist the individuals in locating the cache once they reach the desired coordinates. Reaching the destination may involve walking, fast-paced walking, jogging, hiking on trails, and/or climbing, all of which can range in intensity from light to vigorous. Therefore, if properly designed, geocaching can provide a quality and lifelong physical activity. The purpose of this project was to determine whether a geocaching activity is similar to a walking activity in providing the recommended amount of daily physical activity for youth. Additionally, we sought to compare overall enjoyment levels for geocaching and walking.

Methods

Sampling and participants

Research participants consisted of youth enrolled in a high school serving an entire county in rural western North Carolina. The county has a population of approximately 52 000 residents, with 29% of residents below the current poverty level.[18] A convenience sample of youth in grades 9–12 (N = 83) chose to respond to a recruitment e-mail sent to members of an adventure-based club or 2 varsity sports teams not currently in season (lacrosse and soccer). Eligibility for participation included being able to walk for at least one mile. All testing occurred in the fall semester (eg, October and November) when the daily high temperature ranged between 54°F and 63°F.[19]

Initially, investigators contacted the staff members in charge of each afterschool activity to explain the study protocol and inquire about recruiting participants. Once approval was obtained from the staff, a schedule was created for visiting with the youth and performing each protocol. Informed consents and assents were obtained prior to any data collection and all protocols were approved through the university's Institutional Review Board.

Procedures

Students were required to participate in 3 sessions, one for initial background information and activity instructions and 2 separate activity testing sessions, all of which occurred on or near the high school grounds. Basic measurements were performed at the high school in a classroom, and all physical activities (eg, walking and geocaching) occurred on school sidewalks and a greenway located adjacent to the high school grounds. The 2 activity testing sessions consisted of both a walking activity and a geocaching activity. These sessions were randomized so that half of the groups walked first and half geocached first and vice versa. All testing sessions were performed within a 4-week time frame during the fall semester and occurred after school on nonconsecutive days.

The initial session consisted of collecting height and weight measurements from the students, followed by completion of paper-and-pencil surveys containing questions related to basic demographic information (eg, current grade, sex, birthdate) and previous physical activity participation. Questions about previous physical activity participation came from the Youth Risk Behavior Surveillance Survey and included the following: "Over the course of a week, how many days do you participate in at least 60 minutes of physical activity?" and "Over the course of a week, how many days do you participate in physical education?"[20]

Activity sessions

After the completion of the surveys and prior to beginning any activity testing sessions, students were randomly placed in groups of 3 or 4 and asked to remain in these groups for the remaining activities. In order to ensure that participants understood how to geocache, researchers required all groups to participate in a brief sample geocache session. To prepare for the geocaching session, each participant received verbal instructions followed by a sample geocaching trial on how to operate a GPS device (Garmin eTrex 10). The sample trial required them to walk at a normal pace and find the location of one of our sample cache sites. Once the sample trial was completed, groups were assigned a date to participate in the walking and geocaching activity sessions.

The researchers designed all of the courses, hid each of the caches, and wrote clues for each cache. Both the walking and geocaching sessions were approximately 2.5 miles long with a similar elevation and difficulty level. Prior to assigning the courses to participant groups, the researchers tested the courses and estimated that the time to complete a course was approximately 1 hour. The caches consisted of small plastic containers with lids and a log book inside. As a way for researchers to confirm that students had stayed on task and located each cache, students were instructed to sign the log book upon finding the cache. To ensure their safety, research assistants were located along the courses to observe the students.

Participants remained in their assigned groups for each activity testing session. Prior to beginning each course, the group was provided with a GPS device and students were fitted with accelerometers to be worn during the activity. Accelerometers (GTM1, Actigraph, Pensacola, FL) were used to collect activity levels during the sessions. Following previously accepted protocols, accelerometers were worn above the left hip of each participant, either under or over clothing. The activity counts for the accelerometers were set at 10-second epochs to record the raw data on intensity of physical activity during the treatment. Epochs are used when measuring physical activity with accelerometers and indicate the sampling rate of the device. Common epoch lengths for youth range from 30 to 60 seconds in length[21]; however, smaller epochs were chosen for this study due to the relatively short duration of the event.

Enjoyment of the activity

Upon return from each activity testing session, participants were asked 2 additional questions concerning their overall enjoyment and perceived exertion during the activity. Enjoyment was measured using the question, "I enjoyed today's physical activity." Answers were on a 5-point Likert scale, with 1 being *strongly disagree* and 5 being *strongly agree*. The rating of perceived exertion (RPE), on the other hand, asked "How hard do your feel this activity was today?" and used a Likert scale of 0–10, with 0 being *easy* and 10 being *very, very hard*. Using this type of RPE scale has been suggested to be a valid indication of quantifying exercise sessions.[22] Accelerometers and GPS devices were also collected upon return. Data from the accelerometers were then downloaded and MeterPlus 4.2 software was used to reduce and analyze the data. Cut points used in analysis were as follows: sedentary activity < 100, light activity < 900, moderate activity < 2200, and vigorous activity ≥ 2200 counts.[23] Moderate and vigorous activity were combined and used as a total amount of physical activity (MVPA).

Statistical analyses

All data were entered into Excel and imported into SPSS version 20.0 for statistical analysis. First, basic demographics were reported with descriptive statistics using means and standard deviations. Next, an independent samples t test ($P < .05$) was used to determine initial differences in physical characteristics of boys and girls. Lastly, a paired samples t test ($P < .05$) was used to determine differences within each activity session in terms of light PA, MVPA, and total active time, and a Wilcoxon signed rank test ($P < .05$) was used to determine changes in enjoyment of activity and end-of-session RPE.

Results

Physical characteristics of the sample

Of the 83 total youth invited to participate, 53 completed at least one of the physical activities (eg, walking or geocaching) but only 31 (8 out of 34 boys and 23 out of 49 girls) completed both activity sessions. The sample consisted of mostly high school freshmen (53%), with the remaining being upperclassmen. The mean body mass index (BMI) for the total group was normal (22.8 ± 4.9 kg/m^2) and only 23% were above the overweight classification according to BMI (>85%). The only significant differences detected between boys and girls were in height; that is, boys were significantly taller (170.1 ± 6.9 cm) compared to girls (160.7 ± 6.3 cm).

When asked how many days a week they participate in physical activity, only 10% met *2008 Physical Activity Guidelines for Americans*[6] recommendations of 7 days per week, and 23% reported being active at least 5 or more days a week. Similar results were found with participation in physical education; 34% reported having not participated in physical education during the past week. The Youth Risk Behavior Surveillance Survey questions regarding previous participation in physical activity were asked in order to provide background information regarding the youth involved in the activity and to provide relevance to the amount of physical activity obtained during the geocaching activity. Physical characteristics of the total sample, as well as differences between boys and girls, are reported in Table 1.

Geocaching and walking

No significant differences were detected between walking and geocaching in terms of either time spent in or intensity of the activity. Instead, walking and geocaching were similar in terms of physical activity intensity and total time to complete the activity (Table 2). As predicted, both activities (eg, geocaching and walking) took a little under 60 minutes to complete.

From the initial 83 subjects recruited for the study, a total of 68 participants completed the pre and post questions for this aspect of the study. Results from the Wilcoxon signed ranks test revealed a statistically significant difference in the perception of effort between the activities. RPEs were significantly higher in the geocaching activity, $z = -2.91$, $P < .05$, with a small to medium effect size ($r = 0.25$). The median score on the RPE increased from walking (Md = 2.00) to geocaching (Md = 3.0). Despite significantly higher ratings of perceived exertion for geocaching than walking, adolescent participants reported similar enjoyment levels for each activity (Table 3).

Table 1. Basic physical characteristics of high school students ($N = 31$) participating in geocaching and walking activities.[a]

	Total ($N = 31$)	Boys ($N = 8$)	Girls ($N = 23$)
Age (years)	15.6 ± 1.1	15.2 ± 1.3	15.7 ± 1.1
Height (cm)	163.1 ± 7.6	170.1 ± 6.9*	160.7 ± 6.3*
Weight (kg)	61.1 ± 15.7	64.8 ± 13.8	59.9 ± 16.3
BMI (kg/m^2)	22.8 ± 4.9	22.2 ± 3.6	23.0 ± 5.3

[a]BMI indicates body mass index. BMI ≥ 25 suggests overweight or obese.
*$P < .05$.

Table 2. Comparisons of physical activity levels of high school students ($N = 35$) participating in walking and geocaching.

	Walking	Geocache	P value
Light activity (counts/min)	39.4 ± 11.9	42.8 ± 9.7	.23
Moderate–vigorous (counts/min)	6.7 ± 7.9	5.0 ± 4.3	.15
Total active time	55.0 ± 13.7	56.8 ± 12.7	.65

Table 3. Descriptive statistics ($N = 68$) for enjoyment and RPE of walking compared to geocaching.[a]

	25th Percentile	50th Percentile	75th Percentile
Walking enjoyment	3.00	4.00	5.00
Geocaching enjoyment	3.00	4.00	5.00
Walking RPE	0.00	2.00	4.00
Geocaching RPE	0.25	3.00	5.00

[a]RPE indicates rating of perceived exertion. Enjoyment was measured on a 5-point Likert scale and RPE was rated on a 10-point Likert scale.

Discussion

From this study, findings indicate that geocaching is comparable to walking in terms of physical activity. More specifically, youth spent a similar amount of time in light and moderate–vigorous activity during both the walking and geocaching activity, even with the added task of having to use a GPS device to locate coordinates and find caches. Although respondents reported higher rates of perceived exertion for geocaching compared to walking, they also reported relatively strong and statistically similar levels of enjoyment for both. Lastly, despite the reported inactivity of our sample, the intervention provided almost 60 minutes of physical activity. Collectively, these results suggest that geocaching may be a suitable alternative to improving daily physical activity amounts in youth.

Youth in the study reported enjoying both walking and geocaching and perceived both to be relatively easy activities to perform. This is important to note because geocaching introduces additional challenges compared to walking. More specifically, geocaching requires other skills, such as map reading, GPS proficiency, intragroup communication, and good observational skills, in order

to locate the caches. Given that previous research has found that the accumulation of physical activity throughout the day may be quite meaningful in the weight status of youth, results from this study suggest that geocaching may be a promising alternative to walking as a viable form of activity.[24]

Geocaching can also be thought of as modern-day orienteering; instead of relying on a map and compass, geocaching utilizes GPS technology to assist in locating the cache. In contrast, orienteering participants utilize a specialized, detailed map with information about the area to be explored. In competitive orienteering, participants are charged with reaching the finish in the shortest amount of time, requiring them to read maps on the go, thus making it necessary for participants to perform multiple skills at once. Cych[25] discussed the relative complexity of competitive orienteering in children. It was stated that when children and youth were involved in competitive orienteering, older youth (eg, 10–12 years old) spent more time map reading during walking and standing compared to the younger group (8–10 year olds), who spent the majority of their time running or walking.[25] Thus, Cych[25] suggested that the slower times reported in the older group were due to paying attention to the maps and clues versus trying to get to the next check point. Similarly, our results indicated that though the geocaching session was similar in length (eg, time) to the walking session, youth spent slightly less time in MVPA and more time in light PA, suggesting that groups may have spent more time standing, or searching for the cache, compared to when they were walking. However, even with the inclusion of an additional component to walking (eg, searching for a cache), geocaching was rated similarly by participants in terms of both levels of enjoyment and perception of difficulty. As such, geocaching may provide youth with a suitable alternative to walking.

The point of this research is not to present geocaching as a definitive means for increasing physical activity for youth. Instead, we suggest that opportunities to geocache may be an available means to motivate youth to be active, given that they are more likely to participate in activities they perceive as enjoyable. Our current findings regarding the potential for geocaching to increase physical activity are similar to recently published results regarding exergames that utilized 2 different GPS-based smartphone applications, the Geocaching smartphone application (note that our study evaluated Geocaching using handheld GPS units rather than the Geocaching application available on a smartphone) and "Pokemon Go!" Though smartphone applications have been shown to be a distraction for physical activity in at least some cases,[26] they have also been found elsewhere to serve as an avenue to promote physical activity.[27] For example, college students who downloaded and used the Pokemon Go! app showed an increase of over 30% in their walking behavior and a decrease of 25% of their sedentary behavior. Though Pokemon Go! may be a more recent phenomenon, geocaching is a simpler platform with significantly more play opportunities. As such, it has the potential to offer those inspired by Pokemon Go! and other trending software applications a more long-term impact.[28]

Finding physical activities that are appropriate and engaging is a challenge in this age group. Geocaching has the ability to engage the participant by providing some of the psychosocial aspects of physical activity. For example, when Garney et al[15] asked current geocachers why they geocache, they explained that they enjoyed being outside and the social interaction and the relaxation it brought. In addition, they indicated that it made them feel as if they belonged to a community.[15] This, along with our results, suggests that geocaching may improve physical activity participation by involving more of the psychosocial motivators of physical activity participation.

Providing opportunities for physical activity that connect with technology-savvy youth and appeal to their sense of enjoyment further supports the utility of geocaching as a possible means for promoting physical activity in today's youth. For example, Graf and colleagues[29] used technology (eg, exergaming) with children in order to increase energy expenditure. They found that exergaming may be a potential alternative activity because it was able to increase energy expenditure in a way that was considered acceptable by children due to its perceived entertainment value.[29] Though computers and technology may be linked to sedentary activity in youth, they are likely to be part of our society for quite some time. Capitalizing on the potential for technology to increase the time youth spend being active has therefore become essential.

Given that current recommendations suggest that youth participate in at least 60 minutes of daily physical activity and that most youth report being relatively inactive, finding acceptable forms of physical activity for youth is critical. Ideally, physical activity opportunities should not only meet the recommended levels but should be easily accessible and fun.[30] Weiss[30] suggests that a component of fun is perhaps the most important in terms of the adoption of lifelong behaviors. Considering the increased importance and value of technology in youth and culture today, the use of technology could be especially beneficial as a means to

promote physical activity and increase activity levels among youth.

The authors recognize that, as with most studies, this research is not without limitations. First, the cut points used for the study were based on children ranging in age from 6 to 16 years. As such, it may provide some over- or underestimation of actual time in various physical activity intensities. Second, because students had to be able to participate in 2 afternoon sessions of data collection, students with afterschool jobs, those practicing with either a sports team or the band, and those who were unable to secure transportation home were excluded from being able to participate in this study, likely having an effect on our relatively small participant numbers. Plausible explanations for the low participation rate may also have been due to participants not attending the afterschool club/event on the afternoon of a particular testing session when their group was scheduled and/or needing to leave early due to parents' early arrival for their pickup from school. In order to accommodate for these conflicts, researchers held multiple testing sessions to allow students to use one of them as a makeup day. Though that made a difference in retention, it was not sizable enough to limit the attrition of participants from 83 interested students to 31 students on whom all data were collected.

Additionally, a third limitation to our findings may have been that students had to participate in groups of 3 or 4 in order for the research team to accommodate supervision requirements. As such, groups may have consisted of one (or more) youth who really wanted to participate and would have been more physically active on his or her own but was held back by others who were less interested. Finally, the questions used regarding overall enjoyment of the geocaching activity have not undergone extensive reliability and validity evaluation. However, they were used as part of a larger scale addressing geocaching interest/ability that was shown to have suitable reliability.[16]

Translation to Health Education Practice

In conclusion, the results from this study suggest that geocaching serves as an appropriate means for promoting physical activity among youth and leads the researchers to recommend 3 primary methods of increasing physical activity through the use of geocaching. First, geocaching could be considered for inclusion in afterschool programs. The period of time immediately following school is an important time for children to be physically active and has been described as the "critical window" for children's physical activity.[31-33] This afterschool time period typically represents one of the largest blocks of discretionary time in a child's day. As a result, afterschool programs are considered to have great potential to provide opportunities for increasing physical activity.[2,34]

Second, geocaching might be incorporated into the health and physical education curriculum. According to Pate et al,[9] health and physical educators should be learning to "master behavioral approaches to enhancing youth physical activity, practice communication and collaboration skills, and work with diverse learners."^(p1217) Communication and collaboration skills, as well as the ability to work with diverse learners, are likely outcomes of geocaching. The geocaching activity in this study took just under 1 hour and was performed on and near the school grounds. Lastly, geocaching could be a low-cost programming option for community recreation and tourism facilities. Once cache sites are developed and entered into free web-based software (geocaching.com), little is needed for youth or anyone to be able to participate in geocaching. GPS units could be purchased and made available for rent where existing infrastructure exists, such as at a community recreation center. In addition, the prevalence of smartphones suggests that many participants would be able to participate on their own, using their smartphones and the applications available for these phones at no cost to use.

The recommended steps to design a session using geocaching as an activity include setting up the infrastructure, implementing a program, and promoting the activity.[16] The infrastructure necessary to perform a geocaching activity includes having program administrators locate any caches that may be in a particular area for participants to search, determining the appropriate coordinates or clues that are on the geocaching website, and helping the participants understand how to use these to locate a cache. As in our activity, we provided a practice session with the participants to further encourage success in completing the activity. Depending on the availability of funding, it may be helpful to either provide the participants with a GPS device or show them the app on the smartphone. Once the infrastructure is in place, programs can be developed around geocaching. These could easily be classroom based activities, afterschool activities, or even family activity nights. In our activity, we placed the participants into groups of 3–4 to encourage and support some social interaction while performing the activity. Finally, the last step would be to promote or market the program with the goal of increasing interest in the activity. More information regarding creating geocaching activities can be found in Battista et al.[16]

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