
Journal of
Virtual Worlds Research
jvwresearch.org
ISSN: 1941-8477

Volume 3, Number 3
The Researcher's Toolbox, Part II
May 2011

Journal of Virtual Worlds Research
jvwresearch.org ISSN: 1941-8477

Volume 3, Number 3
The Researcher's Toolbox, Part II
May 2011

Developing an obesity prevention intervention in networked virtual environments: The International Health Challenge in Second Life

Sameer Siddiqi, BS
Texas Obesity Research Center, Health and Human Performance, University of Houston

Scherezade K. Mama, MPH
Texas Obesity Research Center, Health and Human Performance, University of Houston
University of Texas School of Public Health

Rebecca E. Lee, PhD
Texas Obesity Research Center, Health and Human Performance, University of Houston

Abstract

Virtual worlds (VW) present an exciting range of possibilities for health researchers and practitioners. The value of this technology lies its ability to tap into non-traditional participant pools, to use innovative and effective forms of social interaction, and to facilitate cost-effective solutions to common challenges. The International Health Challenge (IHC) was a health intervention study done entirely in the VW of Second Life (SL) aimed at determining the feasibility and effect of obesity prevention interventions in VWs. The IHC initially started as a strategy to develop a multicultural obesity prevention project in SL as evidenced by a full service build, activities, and participating resident avatars. Using existing resources and extensive social networks, together with volunteer assistance, the IHC flourished into a full scale health intervention with the goals of improving health knowledge, attitudes and behavior among resident avatars. In the absence of clear technological and methodological precedence, our multidisciplinary team developed a novel system of in-world and Web-based interactive measurement tools, data management solutions, and participant recruitment and retention strategies.

Keywords: Methodology, health intervention, virtual worlds, obesity

Developing an obesity prevention intervention in networked virtual environments: The International Health Challenge in Second Life

Obesity has emerged as a domestic and global epidemic, and there is an urgent need for novel approaches that promote regular physical activity and healthful dietary habits (Low, Chin, and Deurenberg-Yap, 2009; Ogden, et al., 2006; Popkin, 2008). Physical inactivity and poor dietary habits are leading contributors to adiposity in young adults (Jakicic and Otto, 2005; Lang and Froelicher, 2006; “Overweight and Obesity Trends among Adults,” 2008). Regularly maintained physical activity and greater consumption of fruit and vegetables is directly related to longevity and reduced risk and severity of numerous chronic illnesses (Glade, 1999; Joshipura, et al., 2001; USDHHS, 2008b). Despite widespread dissemination and acknowledgment of these messages, approximately three fourths of Americans do not achieve minimum physical activity recommendations, and only one fifth meet daily fruit and vegetable recommendations (Serdula, 2004; USDHHS, 2008a).

Numerous reviews indicate that most individual and community-based obesity prevention and control interventions fail to instill behavior change, have little or no sustained effect on health outcomes, and do not reveal common patterns related to success (Ammerman, Lindquist, Lohr, and Hersey, 2002; Summerbell, et al., 2005). Proposed explanations include a lack of effectiveness, reach, and sustainability (Hillsdon, Foster, and Thorogood, 2005). Innovations in computer-based gaming and electronic content delivery present novel tools for health researchers and intervention participants. Simulated gaming environments have demonstrated enhanced motivation, attention and retention rates by using elements of fun, role playing, immersion, and social interaction (Lee and Peng, 2006; Moreno and Mayer, 2000; O'Grady, 2008). Recognition of these benefits has led to the rise of a genre of “serious video games,” which seek to improve health knowledge and change behaviors and attitudes (Garris, Ahlers, and Driskell, 2002). Online computer-simulated gaming builds upon these features by allowing users to simultaneously interact in virtual environments. The medium also allows researchers to cost-effectively expand sample size and study duration, provide access to underrepresented groups, and improve study automation and intervention fidelity (Bainbridge, 2007; Foundation). Multi User Virtual Environments (MUVEs), defined as synchronous computer-simulated environments designed to facilitate social interaction among uniquely identified users through rich visual, auditory, or textual interfaces, are especially appealing given their large social networks, anonymity and degree of interactivity (Beard, Wilson, Morra, and Keelan, 2009; Siddiqi and Lee, 2010).

Growth of Multi User Virtual Environments

Over the course of the last decade, MUVEs have developed significantly in light of technological advancement and emerging cultural web trends (Siddiqi and Lee, 2010). Popular virtual worlds claim membership in excess of many million users and are built on a host of innovative features emphasizing interactivity, immersion, and user-driven content (Huang, Kamel Boulos, and Dellavalle, 2008). Linden Lab's Second Life (SL), among the most popular virtual worlds, is home to approximately one million active users who are called "resident avatars," and boasts a robust cash-based economy with over $100 million USD in quarterly transactions (Siddiqi and Lee, 2010). Quarterly published benchmarks indicate significant and consistent year-to-year growth in usage, transaction volume and content (Linden Lab, 2009).

The size and activity of SL's virtual community and programmed features, many of which are common to a number of other virtual environments, have attracted a broad array of educators and researchers from varying institutional backgrounds. MUVEs, such as SL, offer an assortment of unique benefits centered on (a) access to diverse, geographically scattered, and at-risk populations, (b) novel forms of action and design not feasible in real world settings, and (c) significant improvement in existing forms of interaction through cost-effective solutions (Siddiqi and Lee, 2009).

Behavior Change Theory Supporting MUVEs

The use of virtual worlds for health research is supported by a number of behavioral theories which can be related to the medium's unique features. Contemporary MUVEs rely on modeled and textured three-dimensional landscapes and objects, anonymous customizable avatars, audible and textual input and output, and story lines to create a sense of audiovisual and character immersion. Entertainment modules within SL add elements of gaming, which have been shown to enhance participation in health interventions (Lee and Peng, 2006). The medium's immersive qualities add novel degrees of interaction and realism (Inoue, 2007). The Ecologic Model of Physical Activity, described by Spence and Lee (2003), supports the use of this technology in interventions. The model describes relationships among diverse environmental influences, social interactions and physical activity, which can be simulated in SL. Personal anonymity promotes greater interaction between participants, which may also contribute to greater intervention effectiveness (Boulos, Hetherington, and Wheeler, 2007).

Social interaction within MUVEs is a principal component of the technology's appeal and usefulness in health interventions. Social interactions can lead to group cohesion—the affinity, attention and identity of an individual to a specific group and group related tasks—and has been shown to improve participation and outcomes in health interventions (Estabrooks, 2000). The ability to simultaneously interact with thousands of users via various channels of communication all through the lens of a customizable avatar challenges traditional understandings of social interaction and resulting cohesion. It is unclear whether and to what degree cohesion develops in MUVEs and whether traditional strategies for real life are applicable in MUVEs; however, the medium shows great promise for increasing cohesion around improving lifestyle habits.

Rationale and Purpose

Although the utility of virtual environments in health interventions is theoretically well founded, information, protocols and methodology related to implementation and development is sparse (Bainbridge, 2007; Baranowski, Buday, Thompson, and Baranowski, 2008). Leading scientific institutions have recognized the urgent need for additional research (NIH Enterprise Architecture, 2007; National Science Foundation, 2008). This gap in the literature is especially problematic given the array of unique considerations associated with health interventions, including handling participant confidentiality and privacy, data management, survey and logging instrumentation, and content delivery. There is need for formative research and innovation to help researchers establish a body of measurable best practices and methodologies.

This article presents the methodological development of the International Health Challenge (IHC), an obesity prevention intervention aimed at increasing physical activity and improving dietary habits knowledge and behavior in the MUVE of Second Life. First, the theoretical methods used to setup the IHC and manner in which the project was informed by prior projects and behavioral theories is briefly introduced. Then, the methodology used to develop and operate the site and attract and manage participants is discussed. Participation data is reported and analyzed to assess the feasibility of the study's methods. Last, limitations and recommendations for future study are presented.

Method

Study Design

The International Health Challenge (IHC) was initially developed as a means to extend the operations of the University of Houston's Texas Obesity Research Center into Second Life ("Texas Obesity Research Center," 2009). The purpose of the IHC was to assess the acceptability and feasibility of a virtual, behaviorally-based intervention aimed at increasing knowledge, improving attitudes and increasing physical activity and healthful dietary habits by developing an interactive, multilingual and multicultural project in SL.

The IHC was divided into four phases: (1) development of the virtual build in SL, (2) virtual and real-world outreach and recruitment done to foster interest within relevant interest groups in SL, (3) concurrent monitoring and coordination of in-world participants, and (4) data preparation and analysis. Phases 2-3 encompassed the intervention.

Intervention Design

Upon providing consent to participate, participants were required to complete a pre-intervention health assessment (T1). Every week thereafter for four weeks, participants were invited to complete a physical activity monitoring log (Check and Line Questionnaire, CALQ), dietary habits monitoring log (Vegetable and Fruit Log, VF Log), and health knowledge quiz (Lee et al., 2011). Each week's instruments were only made accessible once the participant had been enrolled for an appropriate amount of time (e.g., Week 3 Health Quiz would be available after 14 days of enrollment). All participants were also encouraged to use interactive incentivized "camping" equipment simulating health promoting physical activity and dietary habits. After the 28 day participation period, participants were invited to complete the initial entry survey a second time (T2). Access to the T2 survey remained open for two weeks after the 28 day period.

Eligibility

In order to be eligible to participate, study participants were required to (1) be able to read and write in English, Spanish, or French, (2) have an existing resident avatar or the ability to create one in SL, and (3) have regular access to SL. Eligibility criteria were stated in the consent form offered to all interested individuals. The consent form complied with the University's Institutional Review Board regulations protecting human research participants and included a brief outline of the study's purpose, background, procedure, and eligibility criteria and discussion of risks, costs, benefits, and the author's intention to publish findings.

Development of the Virtual Build: Build Layout

The earliest phase of the IHC was devoted to developing the virtual build within the MUVE of Second Life. A 30m x 30m plot of virtual space was provided by the University of Houston Department of Health and Human Performance on its private land mass (region) within SL known as the HHP Island. The platform was suspended hundreds of meters above the region, isolating the space to ensure privacy and reducing the likelihood of unintended access. The build's open-air layout took full advantage of user controls within SL by reducing the number of walls and roofs, thereby facilitating effortless avatar flight (a core feature of SL) and smooth camera control, enhancing the user experience. The primary means of access to the site was through an elaborate teleport mechanism. Upon arriving at the HHP Island, SL residents were directed via text signage to the teleport mechanism which transported them to the study site. All SL residents were allowed to freely visit the IHC build by locating the HHP Island via SL's search function (keywords: hhp, university of houston, international health challenge, health human performance). To prevent disruption and abuse by visitors, a phenomenon referred to as griefing within MUVEs, residents could be temporarily or permanently removed from the site by the study's principal investigator. The site was designed with a vivid visual aesthetic incorporating an array of decorative plants, bright colors, and geometric forms.

The site was functionally divided into four zones: (1) a physical activity camping pavilion, (2) a café food sampling pavilion, (3) a survey and study information pavilion, and (4) a group activities courtyard. The physical activity camping pavilion was an open rectangular building that housed 4 treadmills, 4 stationary bicycles, 4 trampolines, 4 dance pads, and a large slide show screen where residents viewed rotating educational content. Presentations alternated in English, French, and Spanish. Messages were linked to educational content from quizzes, to provide a learning opportunity while participants were interacting on the site. Content was based on national guidelines and literature from prior studies seeking to affect knowledge of and attitude toward physical activity and diet (Lee, Mama, Medina, Edwards, and McNeill, 2011; Mama, Medina, Edwards, McNeil and Lee, 2010; SAving Lives Staying Active," 2009). Several examples of slides are presented in Figure 1.

Figure 1. International Health Challenge Slides in English, Spanish and French

Each of the 16 physical activity resources was incentivized through Linden compensation and participation points (see Table 1 for amounts). Physical activity resources were designed with careful attention to realism. Upon interacting with physical activity resources, residents were animated in a manner appropriate to each type of equipment (e.g., walking in place for the treadmill or jumping in place for the trampoline). Participants could camp up to 30 minutes per day, after which they were automatically removed from the machine and prevented from accessing it again for 24 hours. Thirty minutes was used to comply with national minimum physical activity guidelines and to simulate the time limit employed in busy real-life gymnasiums.

The café food sampling area was an open air café complete with a lounge and a refrigerator containing food items. Participants were able to select a fruit, vegetable or other healthy snack from the refrigerator and receive a Linden dollar amount, participation points, and note card along with their selection. Available food items offered high nutritional value with low calorie value. Each note card contained a simple recipe, seasonality, and storage information specific to each of the twenty-five food items. The cafe also included a large slide show screen where residents viewed rotating educational content as described in Figure 1.

The Information Pavilion housed key participant assessment instruments. These included: weekly Check And Line Questionnaire (CALQ) for monitoring physical activity habits, weekly Vegetable and Fruit Log (VF Log) for monitoring dietary habits, weekly educational quiz, which mirrored the information presented on the slide show within every pavilion, and pre- and post-intervention outcomes surveys. The information covered in the slide shows and quizzes was also presented as note cards with greater detail that could be accessed in the Information Pavilion. All of these instruments were incentivized with Linden dollars and participation points and were available in English, French, and Spanish. Incentive information is presented in Table 1. Access to each instrument was restricted to enrolled avatars that were in specific periods of the intervention (e.g., CALQ Week 1 was only available during the first week of each avatar's intervention period); avatars outside their window of access were notified via a text message the number of days they had until they would be given access. Instruments were scripted as web forms using HTML, XML, and PHP and were located on secure HHP servers; access was permitted only through the SL client by an enrolled avatar. Data were relayed between the forms, SL, and a database via an XML-RPC protocol.

Participant Activities	Lindens ($L)	Points
Consent and Survey Time 1	50	1
Educational quiz games	20 ($5L per week)	1
NIH Fruit and Vegetable Screener	40 ($10 per week)	1
Check and Line Questionnaire	40 ($10 per week)	1
Survey Time 2	50	1
Camping in Physical Activity Pavilion	168	1
Camping in Café Pavilion	28 ($1L per 28 days)	1
Participant Compensation Total	397	1

Table 1. Incentives awarded for assessments and activities

The final and largest segment of the build – the group activities courtyard – consisted of an open, landscaped area which housed the challenge board, dance area, contest board, and seating. The country team challenge board presented summed totals of individual participant participation points by country team affiliation accumulated throughout the course of the study. Data were visualized through a thermometer-like mechanism. The dance area consisted of an open area centered on an object (dance ball) which animated consenting avatars with randomly assorted dance animations. The contest board allowed IHC staff to administer incentivized group contests. These three objects were placed to facilitate group activity.

All interactive objects throughout the site, with the exception of the entry survey, could only be manipulated by residents enrolled in the IHC; those not enrolled were notified via a text message in the chat dialogue that they were required to join the study to gain object access.

Build Development. All objects and scripts were developed over the course of five months through extensive collaboration between trained research team members and volunteer and paid in-world contractors using open-source and proprietary scripts (Mornington, 2008). A number of freely available objects, or "freebies," were located and obtained through various in-world repositories and directories. Finding virtual contractors familiar with educational or research-oriented production, learning basic object generation and site design skills, and aligning expectations with SL's technical capabilities proved especially time-consuming for the research team.

Virtual and Real World Outreach

Passive Recruitment. The second phase of the study was geared toward recruiting participants through passive interest generating efforts and active on-site engagement of SL residents. IHC researchers participated in discussions with prominent in-world Groups associated with health issues and/or nonprofits, namely Commonwealth, HealthInfo Island, SL Educators Network, and Nonprofit Commons. Collaboration with these entities provided access to a number of potential participant pools and valuable guidance in finding development resources. Brief text advertisements and posters promoting events, such as contests and dance parties, on the IHC site were placed on SL's Community Events calendar and at relevant in-world conferences (n = 2) and health related locales (n = 3). Press releases promoting the study and enrollment were actively distributed and published in real life national, campus, and local news entities (n = 5), relevant campus and community email listservs (n = 3), and SL blogs (n = 1). Promotional material outside SL generally focused on the innovative nature of the study, technology, and health knowledge; whereas, material for use in SL focused on incentives, health knowledge, and entertainment value.

Active Recruitment. Active recruitment, which ranged from October 2008 to November 2008 and January 2009 to April 2009, consisted of targeted participant engagement within SL by in-house recruiters in compliance with a scripted recruitment protocol developed for this study. The recruitment protocol was based on prior participant-based MUVE and real-world interventions protocols. The protocol targeted SL resident avatars and locations (specific locales accessible via keywords) and used scripted dialogues and systematic documentation procedures. Trained recruiters followed scripts as verbal and behavioral guides, rather than verbatim, to simulate more natural interaction. Recruiters documented the proceedings of their recruitment sessions in daily reports, listing start and stop times, the names of all avatars the recruiter interacted with, the types of interaction (engaged, recruited, or followed-up), and notable observations and comments. Daily reports served the dual function of not only documenting findings but also ensuring recruitment was conducted systematically.

Twelve graduate and undergraduate researchers were trained using the protocol and scheduled to recruit on a routine basis. Researchers all spoke English, some spoke English and French, English and Spanish, or all three languages. Training consisted of reviewing pertinent study literature and protocols, scripts, and background on SL, shadowing existing staff in recruiting locales, and completing the entry survey. This process lasted for approximately two weeks. All were required to have received a current US National Institutes of Health Certificate for the Protection of Human Subjects. In light of the project's international scope, there was considerable difficulty in identifying and securing comparable certification for those outside the US. Weekly meetings were held in SL summarizing progress, sharing receptive locales within SL, and discussing effective strategies were held throughout active recruitment periods.

Recruitment took place on various locales considered to be receptive, both with regard to the rules on solicitation and the attitude of resident avatars. Recruitment conversations with individuals and groups focused on research within SL, the purpose of the IHC, and incentives.

Recruiters were not required to meet a quota or screen participants. Recruiters invited participants to join the "International Health Challenge" group in SL, because groups, being a central unit in the social structure of MUVEs, offer a number of unique benefits. Membership in the group allowed for mass messaging, customizable access rights, and secure modes of private communication. All enrolled participants were routinely encouraged to invite their peers within SL to participate, although no additional compensation was provided to participants who did invite friends.

Retention. Throughout the duration of the project, participants within the 28 day enrollment period received regular follow-up contact using a structured protocol based on prior participant-based MUVE and real-world interventions, using text messaging, group announcements and personal conversations. Participant residents who were actively recruited were assigned to their respective recruiter; participants passively recruited were randomly assigned to a recruiter on the basis of workload. Recruiters followed-up with participants every two to four days, a total of 11 times throughout the duration of their participation. Follow-ups 1 and 2 introduced avatars to core interactive components, follow-ups 3, 6, and 9, urged avatars to complete weekly activities (monitoring logs and quizzes), and follow-ups 4, 5, 7, 8, 10, and 11 asked participants whether they had any questions on specific activities. Messages would be tailored to each participant based on her or his progress in the study. In addition, uniform daily text messages were sent individually to all enrolled participants within the 28 day period urging them to complete various activities. Examples of daily messages are presented in Table 2.

1. Today is a great day to be healthy! Join us at the International Health Challenge site to earn free Lindens, learn about healthful habits, and meet other avis interested in health like you! http://slurl.com/secondlife/HHP%20at%20UH/59/169/451
2. Got lindens? Did you know that you can earn Lindens every day? Visit the International Health Challenge site daily to earn Lindens for doing physical activity or trying a new food from the refrigerator. http://slurl.com/secondlife/HHP%20at%20UH/59/169/451

3. Don't forget to complete your weekly physical activity and fruit and vegetable logs. Logging your activity and dietary habits can increase awareness about healthful living! Of course, you'll also receive $10L for every log you complete. http://slurl.com/secondlife/HHP%20at%20UH/59/169/451

Table 2. Examples of Daily Messages

Weekly group activities were also held to boost retention. Activities included dance parties, complete with animation scripts and competitive contests, and were promoted through daily messages, classifieds, group announcements, and recruiter follow-ups. Attendance was incentivized through monetary awards. Contest topics were modeled after other popular contests in SL, and contest winners were decided by polling dance party and contest attendees who were not members of the IHC research team.

Intervention Content

Content. Recommendations about physical activity and dietary habits were adapted from published national guidelines and techniques and strategies shown to be effective in previous real-world interventions (Agriculture, 2005; Kristal, Glanz, Tilley, and Li, 2000; McNeill, 2007; Sallis, et al., 2003; USDHHS, 2008a; Whitt-Glover and Kumanyika, 2009). Recipes and dietary strategies included in refrigerator note cards accessible in the Café Pavilion were adapted from a health intervention web site which focused on providing healthy, culturally appropriate food options and preparation techniques ("SAving Lives Staying Active," 2009). Strategies on physical activity were based upon content from physical activity interventions concentrating on social, environmental, and individual factors contributing to adoption and maintenance of physical activity (Lee, Mama, Medina, Edwards, and McNeill, 2011; Lee et al., 2011; McAlexander, Banda, McAlexander, and Lee, 2009).

Country Team. Recruits were invited to affiliate with a country team -- Canada, Mexico, Switzerland, or the United States of America. Country teams each received a point for every activity that each affiliated avatar completed. Points were allocated for each activity, as described in Table 1. The country team that generated the most points over the course of the study would win the International Health Challenge. Recruits were also allowed to not join a country; however, any points that they generated would not be assigned to a country team. Country team points were monitored on the country team challenge board, described earlier. As participants accumulated participation points, the thermometer like mechanism value increased to indicate team rankings.

Health Assessments (T1, T2, Quizzes). The IHC included three primary self-reported health assessments: T1 survey, weekly quizzes, and T2 survey. The T1 survey consisted of segments of many widely used survey instruments, including (1) physical activity habits, (2) dietary habits, (3) psychosocial factors, (4) social cohesion, (5) health knowledge, and (6) general demographics. The T2 survey was an exact duplicate of the T1 survey but was only made available to each participant after their individual intervention period of 28 days. Residents were given an unlimited amount of time to complete the survey but were unable to save progress, insuring that the survey was done in a single sitting for consistent administration.

Physical activity was assessed using the Godin Leisure-Time Exercise Questionnaire. The questionnaire assesses the intensity and duration of weekly physical activity. Reliability coefficients for Godin Leisure-Time Questionnaire for the optimum discriminate functions for maximum oxygen intake and body fat were .83 and .85 respectively, indicating its acceptability in assessing leisure-time physical activity (Godin and Shephard, 1985).

Dietary habits were assessed using the National Institutes of Health's (NIH) Fruit and Vegetable Screener and Fat Screener. Both tools were developed by the Risk Factor Monitoring and Methods Branch (RFMMB) of the National Cancer Institute (NCI) within the NIH to track changes in fruit and vegetable intake. Fruit and vegetable consumption are reported on the Screener in terms of frequency and amount consumed each time over the last month. Correlations were 0.68 in men and 0.49 in women for validity, indicating its acceptability in measuring food intake in adults (Subar, et al., 2001). The Fat Screener, also developed by the RFMMB, measures usual dietary intake of percent calories from fat. Fat intake was reported in terms of frequency over the last 12 months. Correlation between true intake and Screener amounts were 0.64 in men and 0.58 in women, which indicates its acceptability in measuring percent calories from fat in adults (Thompson, et al., 2007).

Health knowledge was assessed using a 20-item quiz on the topics of physical activity safety and injury prevention, goal setting, social support, self-efficacy, relapse prevention, and diet-health awareness. The question content matched information delivered via slide shows on the site and information cards distributed to resident avatars. General demographics were assessed using a questionnaire which included information on gender, insurance coverage, height and weight, ethnicity, and social, employment, and residence status.

Monitoring (CALQ, VF Log, Sensors). In addition to completing health assessments, participants were asked to monitor their dietary and physical habits on a weekly basis throughout the duration of the intervention. The Check And Line Questionnaire (CALQ) was used to measure self-reported physical activity (Lee et al., 2011). Participants were asked to monitor and record their physical activity for seven days, including type of activity, number of 15-minute sessions, whether the activity was continuous or not and intensity. The CALQ has shown adequate criterion validity with self-reported leisure-time physical activity ($r = .119$) and accelerometer measured physical activity ($r = .184$) (Lee et al., 2011). The VF Log was also used to measure self-reported daily fruit and vegetable consumption on a weekly basis. The VF Log has shown adequate criterion validity with the NIH Fruit and Vegetable Screener ($r = .164$) and the NIH Dietary History Questionnaire (Vegetable servings: $r = .302$; Fruit servings: $r = .293$) (Lee et al., 2011). Both surveys were administered via incentivized SL-accessible web form and were made available each week.

Attendance. Participating resident avatars were encouraged, via follow-up messages, to visit the IHC site frequently to complete activities and surveys. Scripted sensors placed throughout the site recorded the identity, frequency and duration of time spent by each visitor on the site.

Evaluation

Data Preparation. All surveys and questionnaires were administered as web-forms within SL's internal internet browser. Data were exported to a secure MySQL database stored on HHP servers. Data were accessible to research team members through a secure username and password restricted interface powered by an open source visualization tool, Drastic Data. Database contents were regularly downloaded to a non-networked, password protected data computer to comply with human research participant privacy protection regulations.

Results

Participant Demographics

Demographic data suggested that SL provides access to a wide array of ethnically, financially and educationally diverse individuals at risk for obesity in real life. In real life, participant residents (N = 162) were predominantly female (65%), overweight (M BMI = 27.2 kg/m2, SD = 7.11), and White (78.4%). An additional 8.6% were Black, 9.9% were Asian, and 3.1% were American Indian/Alaska Native; 13% of participants identified as Hispanic or Latino. About one-third (31.5%) of participants completed college or more at a 4-year university. One-fourth (25.3%) of participants reported to have an income less than $11,000, and 17.9% reported to have an income greater than $75,000. Tables 3 and 4 present participant educational attainment and household income.

Participant Characteristics	Percentage (N)
Never attended school or only attended kindergarten	1.2% (2)
Grade 1 – 8 (Elementary)	1.2% (2)
Grade 9 – 11 (Some high school)	6.8% (11)
Grade 12 or GED (High school graduate)	27.2% (44)
College 1 year to 3 years (Some college or technical school)	32.1% (52)
University 4 years or more (graduate)	31.5% (51)

Table 3. Education level of participants

Participant Characteristics	Percentage (N)
$0 - $11,000	25.3% (41)
$11,001 - $25,000	25.3% (41)
$25,001 - $50,000	19.7% (32)

$50,001 - $75,000	11.7% (19)
$75,001 - $101,000	8.6% (14)
$101,001 or more	9.3% (15)

Table 4. Household income of participants

Attendance and Activity Completion

Participants consistently and regularly visited the site and interacted with intervention components; however, similar to real-life research studies, retention declined as the study progressed. On average, participant residents visited the site 8.6 times or roughly one-fourth (28.6%) of the 28 minimum visits expected for each resident. Most residents (84.4%) used their avatars to engage in camping and sampling fruits and vegetables. A majority of participants (75.6%) completed at least one activity for week one; this amount dropped significantly the following week (30.6%) and steadily thereafter during weeks three and four (24.4% and 22.5%, respectively).

Recruitment and Retention

Recruitment was time-consuming and showed variable success. A majority of participants signed up for the study without being approached by a trained recruiter. Enrollment varied over time; during a month-long peak enrollment period, over 40% of the study's total participants were recruited. On average, approximately 1.3 hours of recruiter time was required to successfully enroll one participant. Out of total number of avatars approached in the 2009 recruitment period (n = 239), nearly one-fifth were recruited, yielding a relatively low recruitment ratio of 19.7%.

Discussion

Results suggest obesity prevention interventions can be effectively designed and implemented within MUVEs. Attendance data showed participants consistently and regularly visited the site and interacted with intervention components as instructed, indicating feasibility. This is further supported by activity completion (CALQ survey, VF log, and informational quizzes), which remained strong among a core base of participants and gradually declined among all participants.

Future studies may need to implement stronger screening strategies on dimensions of motivation, or other predisposing characteristics in order to boost participation. Recruitment findings suggest in-world outreach, promotion, and incentives are effective in attracting a socioeconomically and ethnically diverse group of active participants at risk for obesity. However, individual recruitment efforts, although essential, are time consuming. Retention efforts suggest continuous follow-up can sustain consistent activity completion but must include technologically-appropriate messaging features. Furthermore, this study shows that extended interaction interventions can be performed at low costs in MUVEs.

The IHC provided key insights on designing health interventions in MUVEs. Findings suggest incorporating technical expertise throughout all periods of study design and execution is essential. This is likely because MUVEs have unique feature sets and technical limitations, which must be fully understood before designing components. Furthermore, pilot testing with technical consultation is essential, as bugs and user-experience issues are highly prevalent in virtual settings. Expertise in virtual aesthetics should also be considered, as MUVEs employ a distinct set of features that dramatically alter how spaces are perceived and maneuvered; for instance, users can fly, thereby making ceilings more frustrating than useful.

Recruiting participants in a virtual setting presents a number of challenges. Most notable is the unfamiliarity and expansiveness of the social environment. Direct recruitment through interaction with project recruiters was not the most useful method of engaging participants. Rather, a majority of our participants were recruited via promotion with relevant in-world interest groups, graphical and interactive advertisements, and participant referrals. Furthermore, in virtual worlds with cash-based economies, financial and entertainment incentives can be useful; however, incentive value is relative to the virtual world in which the project is operating. For instance, although a $2 USD incentive is far from acceptable in real world interventions, an equivalent amount in SL may be excessive and create suspicion. Entertainment features are also very important, as fun and game-playing is an essential component of many MUVEs. The delivery and determination of incentives in virtual interventions may need to be reexamined to understand the relationship between competition and participant interest.

Although direct recruitment contributed a minority of participants, it was still useful for attracting a motivated group of participants. A challenge of direct recruitment was developing strategies to promote studies without overstepping virtual community laws. As many MUVEs allow private property ownership, locales may have different sets of rules regarding solicitation and personal demeanor and appearance. Although some land owners refused to allow recruitment on their lands, some were interested in the project and permitted recruitment on their land. We had to develop comprehensive strategies for recruiters to be sensitive to the diverse range of permissions. Second, because MUVEs have a highly dynamic population, locale exhaustion and transformation can occur rapidly. Many of the IHC's most receptive recruiting locales developed a tolerance to recruitment efforts, as residents were largely familiar with the project. In other instances, locales that once were populated and active were deserted over short periods of time. Responding to the dynamism of MUVEs should be a major part of any successful intervention recruitment strategy.

Retaining participants in virtual environments was the biggest problem this project faced, and like retention in real life, retention in virtual worlds presents a number of challenges. Although participant interest in compensation underscored the importance of monetary incentives, SL along with most MUVEs, is saturated with incentivized programs. It is therefore essential for interventions to employ an array of engaging activities, competitive features, and branded objects to keep participants interested in the program. In the IHC, we used progressive content, group gatherings, contests, country team competition and scoreboards, and logoed apparel to develop and sustain interest. In addition, because residents of virtual environments are accustomed to undesirable automated messages delivered through client chat features, we found daily personal follow-ups in the form of instant messages, invitations to activities, and group announcements were more useful than mass broadcasts. Following-up in MUVEs requires the use of innovative and personally tailored modes of communication.

Although the IHC was a great success, we encountered challenges that were insurmountable. The technical learning curve and hardware requirements associated with SL along with most contemporary MUVE clients prevented some prospective participants from enrolling. Furthermore, development of intervention components required technical expertise of the SL client. Since technical features of clients often vary considerably among different MUVEs, it was challenging to find support technicians at our local institution, and considerable resources had to be invested in locating appropriate technicians within SL. Another challenge is the transient nature of MUVEs; their duration is often determined by technology and market competitiveness. We found that SL resident membership periods infrequently surpassed one year. Longer term interventions may not be feasible in this type of environment.

Additional research is needed to better understand individual motivational factors of virtual residents in order to develop more effective and technologically appropriate recruitment and retention protocols. Also, research should be conducted to determine the value of practices acquired in certain types of MUVEs in other virtual communities. Research should also attempt to determine appropriate intervention intensity and length for virtual settings; for many in the IHC, even 28 days was too long a duration. Perhaps the ephemeral nature of MUVEs may be more appropriate for even briefer interventions. The development of this project demonstrated that as in real life, careful attention, planning and resources must be devoted to ensure project success. The growing burden of obesity and the ability to reach vulnerable populations, who may not respond to real-life interventions, make a promising backdrop for the IHC, among the first study of its kind to chart the undiscovered country of our virtual future.

References

Ammerman, A. S., Lindquist, C. H., Lohr, K. N., and Hersey, J. (2002). The efficacy of behavioral interventions to modify dietary fat and fruit and vegetable intake: a review of the evidence. Prev Med, 35(1), 25-41.

Bainbridge, W. S. (2007). The scientific research potential of virtual worlds. Science, 317(5837), 472-476.

Baranowski, T., Buday, R., Thompson, D. I., and Baranowski, J. (2008). Playing for real: video games and stories for health-related behavior change. Am J Prev Med, 34(1), 74-82.

Beard, L., Wilson, K., Morra, D., and Keelan, J. (2009). A survey of health-related activities on second life. J Med Internet Res, 11(2), e17.

Boulos, M. N., Hetherington, L., and Wheeler, S. (2007). Second Life: an overview of the potential of 3-D virtual worlds in medical and health education. Health Info Libr J, 24(4), 233-245.

Estabrooks, P. A. (2000). Sustaining exercise participation through group cohesion. Exerc Sport Sci Rev, 28(2), 1-5.

Garris, R., Ahlers, R., and Driskell, J. (2002). Games, motivation, and learning: a research and practice model. Simul Gaming, 33, 441-467.

Glade, M. J. (1999). Food, nutrition, and the prevention of cancer: a global perspective. American Institute for Cancer Research/World Cancer Research Fund, American Institute for Cancer Research, 1997. Nutrition, 15(6), 523-526.

Godin, G., and Shephard, R. (1985). A simple method to assess exercise behavior in the community. Can J Appl Sport Sci, 10(3), 141-146.

Hillsdon, M., Foster, C., and Thorogood, M. (2005). Interventions for promoting physical activity. Cochrane Database Syst Rev(1), CD003180.

Huang, S. T., Kamel Boulos, M. N., and Dellavalle, R. P. (2008). Scientific discourse 2.0. Will your next poster session be in Second Life? EMBO Rep, 9(6), 496-499.

Inoue, Y. (2007). Concepts, Applications, and Research of Virtual Reality Learning Environments. International Journal of Social Sciences, 2(1), 1-7.

Jakicic, J. M., and Otto, A. D. (2005). Physical activity considerations for the treatment and prevention of obesity. Am J Clin Nutr, 82(1 Suppl), 226S-229S.

Joshipura, K. J., Hu, F. B., Manson, J. E., Stampfer, M. J., Rimm, E. B., Speizer, F. E., et al. (2001). The effect of fruit and vegetable intake on risk for coronary heart disease. Ann Intern Med, 134(12), 1106-1114.

Kristal, A. R., Glanz, K., Tilley, B. C., and Li, S. (2000). Mediating factors in dietary change: understanding the impact of a worksite nutrition intervention. Health Educ Behav, 27(1), 112-125.

Lang, A., and Froelicher, E. S. (2006). Management of overweight and obesity in adults: behavioral intervention for long-term weight loss and maintenance. Eur J Cardiovasc Nurs, 5(2), 102-114.

Lee, K. M., and Peng, W. (2006). A brief biography of computer game studies. In P. Vorderer and J. Bryant (Eds.), Playing computer games: Motives, responses, and consequences (pp. 325-345). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Lee, R. E., Mama, S. K., Medina, A. V., Reese-Smith, J. Y., Banda, J. A., Layne, C. S., Baxter, M., O'Connor, D. P., McNeill, L., Estabrooks, P. A. (2011) Multiple measures of physical activity, dietary habits and weight status in African American and Hispanic or Latina Women. Journal of Community Health . In press.

Lee, R. E., Mama, S. K., Medina, A. V., Edwards, R. O., McNeill, L. H. (2011). SAving Lives Staying Active: SALSA to promote physical activity and healthy eating. Journal of Obesity, 436509.

Linden Lab. (2009). 1 Billion Hours, 1 Billion Dollars Served: Second Life Celebrates Major Milestones for Virtual Worlds. Second Life Press Room. Retrieved March 30, 2010 from http://lindenlab.com/pressroom/releases/22_09_09

Low, S., Chin, M. C., and Deurenberg-Yap, M. (2009). Review on epidemic of obesity. Ann Acad Med Singapore, 38(1), 57-59.

Mama, S. K, Medina, A. V., Edwards, R. O., McNeill, L., Lee, R. E. (2010). A Culturally Friendly Web-based Hybrid Intervention to Prevent Obesity: The SALSA Study. Annals of Behavioral Medicine, 39(Supplement), s89.

McAlexander, K. M., Banda, J. A., McAlexander, J. W., and Lee, R. E. (2009). Physical activity resource attributes and obesity in low-income African Americans. J Urban Health, 86(5), 696-707.

McNeill, L. H. (2007). Feasibility of Using a Web-Based Nutrition Intervention Among Residents of Multiethnic Working-Class Neighborhoods. Preventing Chronic Disease, 4(3), A55.

Moreno, R., and Mayer, R. E. (2000). Engaging students in active learning: The case for personalized multimedia messages. Journal of Educational Psychology, 92, 724-733.

Mornington, S. (2008). IHC Camping Protocols. Personal Communication with Torc Turbo. Second Life.

National Science Foundation. (2008). Netlab Workshop Report, Retrieved March 30, 2009 from http://www.nsf.gov/sbe/ses/soc/asi.jsp

NIH Enterprise Architecture. (2007). Networked Virtual Environments and the NIH Mission: How Virtual Systems Can Assist with Collaboration and Citizen Outreach. Architecture Library. Retrieved March 30, 2009 from http://enterprisearchitecture.nih.gov/About/NewsEvents/News/SecondLifeWhitepaper.htm

O'Grady, L. (2008). The experimental health information processing model: supporting collaborative web-based patient education. BMC Medical Informatics and Decision Making, 8, 58.

Ogden, C. L., Carroll, M. D., Curtin, L. R., McDowell, M. A., Tabak, C. J., and Flegal, K. M. (2006). Prevalence of overweight and obesity in the United States, 1999-2004. JAMA, 295(13), 1549-1555.

Overweight and Obesity Trends among Adults (2008). Retrieved March 13, 2008, from http://www.cdc.gov/nccdphp/dnpa/obesity/trend/index.htm

Popkin, B. M. (2008). Will China's nutrition transition overwhelm its health care system and slow economic growth? Health Aff (Millwood), 27(4), 1064-1076.

Sallis, J. F., McKenzie, T. L., Conway, T. L., Elder, J. P., Prochaska, J. J., Brown, M., et al. (2003). Environmental interventions for eating and physical activity: a randomized controlled trial in middle schools. Am J Prev Med, 24(3), 209-217.

SAving Lives Staying Active (SALSA) (2009). Retrieved March 12, 2009, from http://grants.hhp.coe.uh.edu/salsa/

Serdula, M. (2004). Trends in Fruit and Vegetable Consumption Among Adults in the United States: Behavioral Risk Factor Surveillance System, 1994-2000. 94(6), 1014-1018.

Siddiqi, S., and Lee, R. E. (2010). Building Virtual Communities for Health Promotion: Emerging Best Practices through an Analysis of the International Health Challenge and Related Literature in Second Life. In: Ubiquitous Health and Medical Informatics. Hershey, PA: Medical Information Science Reference.

Spence, J. C., and Lee, R. E. (2003). Toward a comprehensive model of physical activity. Psychol Sport Exerc, 4(1), 7-24.

Subar, A. F., Thompson, F. E., Kipnis, V., Midthune, D., Hurwitz, P., McNutt, S., et al. (2001). Comparative validation of the Block, Willett, and National Cancer Institute food frequency questionnaires : the Eating at America's Table Study. Am J Epidemiol, 154(12), 1089-1099.

Summerbell, C. D., Waters, E., Edmunds, L. D., Kelly, S., Brown, T., and Campbell, K. J. (2005). Interventions for preventing obesity in children. Cochrane Database Syst Rev(3), CD001871.

Texas Obesity Research Center (2009). Retrieved March 30, 2009, from http://grants.hhp.coe.uh.edu/obesity/index.htm

Thompson, F. E., Midthune, D., Subar, A. F., Kipnis, V., Kahle, L. L., and Schatzkin, A. (2007). Development and evaluation of a short instrument to estimate usual dietary intake of percentage energy from fat. J Am Diet Assoc, 107(5), 760-767.

U.S. Department of Health and Human Services and U.S. Department of Agriculture. (2005). Dietary Guidelines for Americans 2005. Retrieved December 28, 2007. from http://www.health.gov/dietaryguidelines/dga2005/document/pdf/DGA2005.pdf.

U.S. Department of Health and Human Services (USDHHS) (2008a). 2008 Physical Activity Guidelines for Americans, Retrieved March 30, 2009 from http://www.health.gov/PAGuidelines/default.aspx

U.S. Department of Health and Human Services (USDHHS) (2008b). Physical Activity Guidelines Advisory Committee Report, 2009, Retrieved March 30, 2009 from http://www.health.gov/PAGuidelines/Report/Default.aspx

Whitt-Glover, M. C., and Kumanyika, S. K. (2009). Systematic review of interventions to increase physical activity and physical fitness in African-Americans. Am J Health Promot, 23(6), S33-56.

Acknowledgements

The authors would like to thank Drs. Catherine Horn, Charles Layne, Colleen Loomis, Brian McFarlin, and Daniel O'Connor for their help formulating and executing the International Health Challenge. Funding was provided by the Culture Network Project, USC Annenberg School for Communication.

Correspondence concerning this paper can be sent to Rebecca E. Lee, 104 Garrison Gymnasium, 3855 Holman Street, Houston, Texas 77204-6015. Address email to releephd@yahoo.com