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Design, Implementation and Evaluation of a Game-Based Intervention Targeting Latino Children for Improving Obesity Outcomes

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Abstract—This paper presents the design, implementation and evaluation of a hybrid clinic plus home based intervention targeting Latino children to improve obesity outcomes. The intervention applies motivational game based learning and behavior change theories during design. Latino American children are the main target group for this study as they have significantly high obesity rates due to socio-economic conditions and lack of awareness. There have been several interventions that have targeted game based strategies in the clinic to promote health outcomes and some have even targeted obesity problems, however to our knowledge this is the first effort that adds an in-home component to the clinical intervention. We discuss in detail the challenges faced while designing and implementing this hybrid clinical trial. Finally, we present the evaluation results from a randomized clinical trial that recruited 101 children.

Keywords—*Serious games; health intervention; behavior change; obesity;*

I. INTRODUCTION

This paper presents the results of the study conducted in both clinic and home and titled Technology Based Obesity Prevention Project (TeBOPP). For the purposes of this paper we would refer to this study/project as TeBOPP. TeBOPP involves developing and testing a bilingual family based and culturally sensitive educational intervention in a video-game format. It was deployed on a portable device and on computer. By targeting both Latino parents and their children simultaneously, this intervention aimed to improve knowledge regarding healthy nutrition and exercise and promote parent-child communication, complement the learning process and improve knowledge sharing. In this exploratory study, children in the intervention group played the simulation avatar-based game in the public hospital or clinic, and allowed additional play opportunities at home to enable them to

advance to the highest level in the game with parental assistance and approval; this was facilitated by logging on to a designated web-page providing the same underlying message regarding healthy diet and exercise. The children in the control group were provided with written materials and multimedia that was accessible online on improving diet and exercise.

The TeBOPP study focuses on utilization of interactive videogame technology to enhance knowledge regarding healthy nutrition and benefits of instilling good eating habits and daily exercise into obesity prevention. This educational intervention is expected to motivate parents and children/teens to adopt healthier lifestyles. A video-game based format was chosen since it is a medium that is extremely popular among children and adolescents. It is more likely to capture their attention than other media and can be easily designed for combined play with a parent, thus encouraging shared learning.

The hypothesis that such an intervention will enhance knowledge is based on recent studies that have explored how avatars may influence individual behaviors cite. Researchers at Stanford have started to explore a concept they have labeled the Proteus Effect [11]. The Proteus Effect is a hypothesis postulating that the behavior of an individual conforms to implicit cues provided via a digital self-representation i.e., avatar [12]. For example, research suggests that if an individual's avatar is created to be taller, this individual acts more confident during negotiation tasks [12]. In other research, individuals that viewed an avatar of themselves running on a treadmill were more likely to exercise than randomized to a non-exercise condition [11]. Based on the Proteus Effect, actions of an avatar, (particularly avatars constructed to look like the individual), can act as a model for an individual's behavior. Previous research from social learning theory has highlighted the power of modeling for

skill-building, behavior change, and shifts in self-identity [13]. In theory, an avatar may be a particularly powerful mechanism to explore for promoting new skills, behaviors, and possibly even self-perceptions and are keys for promoting positive behavior change. TeBOPP combines the fundamental principles of play therapy with cognitive behavioral therapy and develops a video-game based intervention for creating a change in knowledge and attitude among Latino children and adolescents with respect to eating a healthy diet and regular exercise for optimum future growth and development.

Prevalence of obesity among children and adolescents in the United States continue to remain high at 17% but has stabilized over the last decade. However obesity prevalence among racial and ethnic minorities have continued to rise with Hispanic children having a prevalence of 22.4%. In addition to racial disparities among childhood obesity prevalence, significant socioeconomic disparities also exist. Among children whose adult household completed college, obesity prevalence was approximately half of that of those whose adult household did not complete high school [15].

II. RELATED WORK

The idea of using a game based intervention for improving obesity outcomes is relatively novel. A behavior science approach to designing a serious game for obesity and diabetes is presented in [1]. A randomized clinical trial was conducted based on video game play and changes in behavior towards diet and physical activity was observed in [2]. In [3] a detailed review of the potential of video games to tackle obesity is presented. In [4, 5] the importance of story, immersion and narrative to promote behavior change targeting obesity is presented. Broadly games and visualizations have been used to improve clinical outcomes in [6, 7, and 8]. Majority of game based applications have targeted the caregiving side of healthcare in areas such as training, surgery, triaging or workflow. In [9] the research landscape for the use of smartphone in improving health outcomes is presented. In [10] a design of a virtual world to promote infant's physical activity estimation abilities is discussed. This paper provides a comprehensive report on all aspects of conducting a randomized control trial with a game-based intervention. It looks at both the behavior change aspects as well as clinical and home environments for running the intervention.

III. SIGNIFICANCE

Recent years have seen a sharp increase in obesity rates among children and adolescents in the United States. The National Health and Nutrition Examination Survey [15] indicates that almost a quarter of preschoolers (2-5 years) and one third of school age children and adolescents are obese or over weight. There are also significant socio-economic and racial disparities evident and Latino children seem to be disproportionately affected by the current obesity epidemic; 38.6% of Latino girls are overweight or obese compared to 25.6% white girls, the rates are even more alarming at 42.9% among 12-19 year old Latino boys cite. Childhood obesity has

been associated with an increased risk of cardiovascular diseases and Type II Diabetes leading to significant long-term morbidity [16]. Latino children in the United States are currently at the highest risk for developing Type II Diabetes when compared to their white counterparts [17]. Poverty leading to lack of affordability and access to healthy food are some of the major factors that account for high overweight and obesity rates among Latino inner city children and adolescents [18]. In addition, Latino children and adolescents who are highly acculturated to an American lifestyle have poor eating habits with greater dependence on fast food and spend less time on exercise and physical activity [14].

IV. METHODS

The hypothesis for this study was that game-based avatars (i.e., graphical representations of individuals within a virtual space) could create change in knowledge and attitudes toward healthy eating and exercise. The specific aims of the proposed study were limited towards assessing change in knowledge and attitudes towards diet and exercise as outlined below. Change in weight or BMI as a result of this outcome was not an aim of this study hence, weight, actual physical activity was not measured.

1. Conducting a "pre-test assessment survey" among Latino parents who have at least one child aged 8-15 years to understand the socio-cultural factors (knowledge, attitudes, barriers, facilitators, cultural beliefs, acculturation and peer norms) that impact their children's dietary habits and physical activity.
2. Development of a bilingual, culturally sensitive educational videogame intervention using an avatar about diet and exercise for Latino children and adolescents, based on the information drawn from the pre-test assessment survey.
3. Testing of the interactive portable tablet based bilingual (English/Spanish) diet and exercise educational videogame on parent-child dyads presenting to the pediatric emergency department and any of the four Family Learning Centers of an inner city tertiary care teaching hospital.
4. Assessing the impact of the educational intervention by measuring changes in nutrition-related knowledge, parent-child communication, and attitudes toward adopting a healthier lifestyle.

A. Setting

TeBOPP is a prospective study that was conducted in the pediatric emergency department (ED) at the Maricopa Medical Center and the Family Learning Centers (FLCs) adjacent to the outpatient clinics at Maricopa Integrated Health System (MIHS), a large tertiary care public teaching hospital and health care system located in Phoenix, AZ. The combined FLCs had 28,000 visits in 2012 and roughly half of these were children. Families use the FLCs while waiting for

appointments or to attend scheduled programs or just to visit. The FLCs have been successfully used previously as a venue for targeted patient health educational programs.

B. Participants

Patients of Latino ethnicity, 8 to 15 years of age who register in the pediatric ED and patients who visit the FLCs and are accompanied by a parent/guardian who is 18 years or older and able to communicate in English or Spanish were recruited into the study. A patient must have received an Emergency Severity Index (ESI) Version 3 score of 4/5 indicating non-urgent status for recruitment in the pediatric ED. Additionally, the participants had to have internet access at home to complete game levels. This study was done in an inner city setting where majority of the children are of Hispanic /Latino ethnicity. Of them, the overwhelming majority are Mexican Americans. In another study previously published by the authors that assessed access to care, unmet health needs, perceived barriers to care, and compliance with follow up care needs recruited a sample of 385 patients families from the same population group; 91.7% of these patient families were Hispanic, poor (67.8% families reported household incomes less than 100% of the Federal Poverty Level), and 80.8% used Spanish as their primary language at home [23].

C. Needs Assessment

A web-based, bilingual (English/Spanish) needs assessment survey was developed to assess Latino parent-child dyads visiting an inner city public hospital/clinic. The survey assessed their dietary habits and exercise patterns. Although the proposal had initially planned to recruit 25 parents for the survey, the response from the parents, and the ease and efficiency with which the survey was administered, encouraged us to gather data on 102 parent/child dyads over a 14-week period. This strengthened the conclusions from our survey and helped us better understand the dietary habits and exercise patterns in the target population. Recruitment was done at the Pediatric Emergency Department (PED), Pediatric Ambulatory Care Clinic (ACC), and the Family Learning Centers (FLCs). Information from this survey was used for intervention development; key attributes (e.g. risk awareness, facilitators, belief, barriers, acculturation and peer norms) were used to refine video game scenarios making it culturally appropriate. The cross-sectional survey was administered over a 14-week period. Prior to implementation, pilot testing was conducted and the survey optimized. The survey was deployed on a touch screen tablet PC (in PED) and on desktop PCs (in ACC and FLCs). The web based survey is currently available at [20]. Detailed results from the survey are reported in [21].

D. Game Development

For development of content specific to the videogame, a nutritional specialist, who worked with this patient community for the past several years with valuable experience in conducting educational workshops pertaining to healthy diet

and nutrition targeted toward the Latino population, was recruited. The design of the story was based on a multiple story-line multiple ending narrative that was dependent on the food and activity choices made by the child. The plot was chosen to be simple and context sensitive. The main character realizes that his/her parents have been kidnapped by an evil villain and he/she now needs to transform into a superhero and go on a rescue mission. As every superhero needs help from the world around, the player needs to help the superhero complete his/her mission. The superhero needs to eat healthy, eat balanced and eat on-time. The super hero also needs to perform the correct exercises and activities to stay healthy. The narrative then breaks several times during a day long mission to ask the child to assist the superhero and make the appropriate choices. Depending on the choices the player makes the story can have many different endings, however only the healthy choices lead to a successful completion of the mission. The game effectively employs rich narrative with compelling endings to add replayability and test multiple scenarios in a cause and effect setting. Over several iterations of interacting with the story the player builds knowledge on what foods are healthy and balanced and what activities promote physical activity. Figure 1 shows the early morning breakfast narrative where the superhero needs to eat a balanced breakfast. The child starts at the breakfast level in the hospital and upon successful completion is given a code to play the remaining storylines at home. Parents reward the child by giving them meaningful real-world prizes (e.g., water bottle, Frisbee, jump rope, and back pack) as they complete the missions at home.

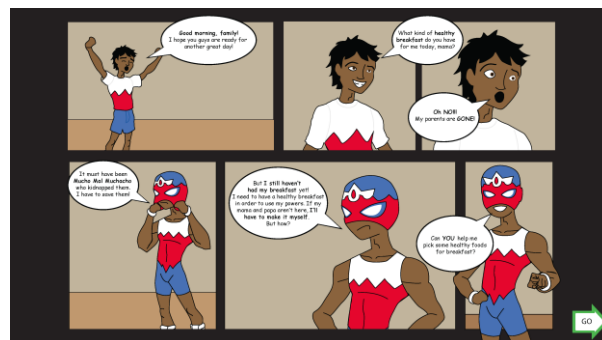


Fig. 1. The breakfast storyline for the morning mission

The game is designed to help children and parents understand what good food and lifestyle choices are, and how they can apply them to their lives. It is designed with the intent that after completion, the child should understand:

- How to choose foods and make a balanced meal (tailored to each meal – breakfast, lunch and dinner)
- Which foods are healthy, and which foods / types of foods to avoid
- How to choose good alternatives to bad food choices

- The importance of eating well, and exercising to stay fit
- How to incorporate exercise and fitness into their everyday lives
- Ideas for exercise and healthy meals

TABLE I. NUTRITION AND ACTIVITY MASTER LISTS

Breakfast item	Score	Activity Item	Score
Apple	1	Bike with Friends	1
Oatmeal	1	Jump Rope	1
Chocolate ice cream	2	Swim	1
Pop tart	3	Lay on couch	3

Two master lists were developed by the nutritional specialist. The lists contained three foods or three activities that when combined together were given a remediation message and a score. The mission is marked to be successful only if the combined score reached a particular threshold. Four distinct narratives were developed based on the score obtained with one of them leading to a successful mission. Table 1 shows a snapshot of the nutrition and activity master lists. The table show the different scores the player can get, 1 always indicates a winning score and the result will be a successful mission and the child will progress to the next storyline in the comic book. The child always selects three food groups to create a balanced meal and three activities that are appropriate for the time of the day and can easily be executed. The explanation provides remediation message on the selected choices and their effect. The child then gets a chance to replay by selecting new choices until a winning combination is chosen.



Fig. 2. Choice selection screen

Each mission has three primary states: story, gameplay, and results. During the story state, the user will be shown a comic strip that depicts the current segment of the story. Afterward, the user will begin gameplay, during which the user will make decisions for the superhero, ranging from what foods the hero should eat for breakfast, to what activities the superhero should perform before he/she leaves the house.

Once the child has made his/her decisions, see Figure 2, the story will manifest into a narrative based on their actions (this is another story panel, not the results screen, where the multiple narratives get forked). Note: if the user made good decisions, the story will progress well; however, if poor decisions were made, the superhero may have a hard time completing his/her mission and have to repeat the previous stage.

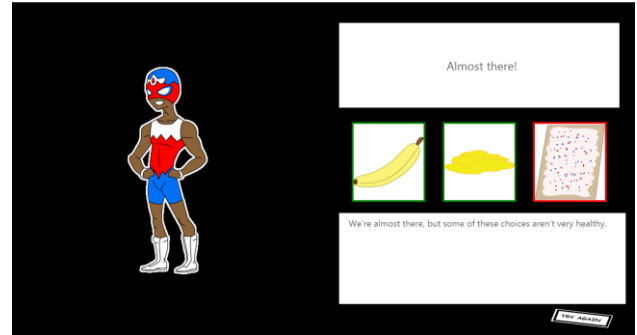


Fig. 3. Results screen

Lastly, the child will be shown their results, see Figure 3, which informs the child which of their choices were good, and which choices should have been avoided. If the child does well, in terms of making the right food and exercise choices, he/she will be able to progress to the next chapter in the story. Otherwise, he/she will retry the game (this time with different choices than before) until the user chooses a winning combination.

E. Usability Testing

Usability testing to determine learnability and ease of use was conducted and involved observations of actual children and parents playing the videogame. The team reviewed the results of the usability testing and analyzed user behavior. Potential problems were identified and measures taken to correct them were outlined as shown in Table 3. These corrective measures required the team to go back to the storyboard designers and the game programmers for modifications. In addition, the translation team completed a full review of the game post modifications to ensure accuracy. This process ensured the game met the intervention targets.

TABLE II. USABILITY ISSUES AND CORRECTIVE MEASURES

	Problems	Corrective measures
Readability	Users had problems with reading all upper case letters and font sizes.	Adjustment of font size and case of dialogues on screen to make script easily readable.
Navigation issues: Lengthy video game strips	Users especially younger children struggled to read through comic strips	Video game story strips separated into smaller frames so that all

	<i>Problems</i>	<i>Corrective measures</i>
	that were long and skipped portions.	the portions are not displayed on the single screen.
Pre-test survey	Pretest survey at the start of the video game distracted the child user.	Pre-test survey removed from the videogame.
Language choice for play	Difference in language choice between child and parent was observed commonly.	Providing parent and child with two tablets could be considered.
Child and parent combine play	When given the choice to pick a healthy meal in order to advance in the game, kids would ask the parents for help at this point and both would briefly work together to pick out a balanced meal.	Positive observation: Encourage child/parent combined play.

F. Implementation

A research assistant collected basic demographic data during the pre-intervention (T1) phase from both comparison and intervention group enrolled. The parent/child dyad was also assessed for internet availability at home so they could continue play once they left the recruitment site. This was needed to enable the game play at home. In addition a pre-questionnaire was given containing the following:

- A brief 7-item multiple-choice questionnaire to assess baseline knowledge regarding the obesity prevention will be administered to parents.
- Question relating to parent-child communication regarding need for adopting healthy diet and exercise.
- Question regarding parent’s intent to adopt a healthier life style for their child.
- Eligible Parent/Child dyads would then be randomized to Intervention and Comparison groups
- Intervention: Both the parent and their children will then undergo an obesity prevention education intervention aimed at improving knowledge and attitude; this will be in a video-game format, in the FLC’s parents and children will play the game on desktop PC and ED patients on a portable tablet PC. The parent/child dyad was then randomized to the Intervention or Control Group. The Intervention group played the Breakfast levels of the game while the research assistant observed. The game is available to play at [19] and the login ID can be chosen as any 2 alphabets followed by any 4 numbers.

- Control: In the control group upon discharge, parents/patients were provided printed education materials in English/Spanish promoting healthy diet and exercise. Core content for nutrition education were adapted from Centers for Disease Control and Prevention’s Division of Nutrition, Physical Activity, and Obesity (DNAPO) patient information resources [22].

During initial recruitment efforts, parent/child dyads that had access to the internet via a tablet or computer were identified for enrollment. When efforts to find parent/child dyads that met this requirement were not being met, access to the internet via a phone was also added as an option for home play since the game could be played on a smart-phone. This increased the number of participants eligible for the study.

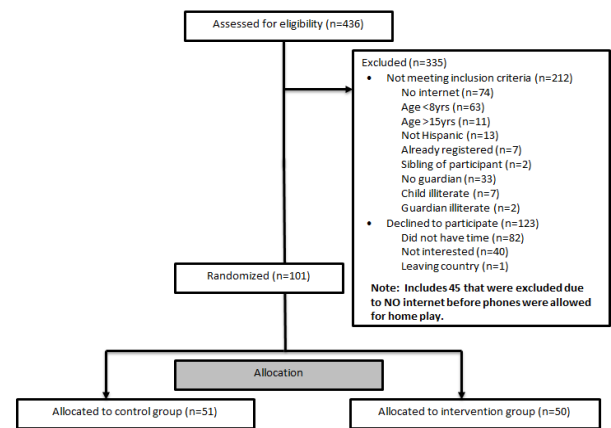


Fig. 4. Consort flow diagram

The perceived value of the game to the parent was assessed during the immediate post-intervention (T2) phase by a simple satisfaction survey among the intervention group. This satisfaction survey contained questions regarding computer usability and interface. The intervention group was given instructions to continue game play at home. The parent was also provided the prizes to reward their child after the Lunch and Dinner levels of play. Once all levels were played, the same questionnaire was administered to assess immediate post-videogame play knowledge change in the intervention group. The Comparison (no-intervention group enrollees) was provided printed education materials in English/Spanish promoting healthy diet and exercise at discharge from the ED or prior to their departure from the FLCs. See Figure 4 for Consort Flow Diagram outlining recruitment. Two months post initial recruitment (T3), the parent/child dyads from both the intervention and control groups were contacted by the research assistant. They were asked to complete the same questionnaire used in T1 and T2.

V. RESULTS

A total of 436 children were assessed for eligibility and of those, 335 were excluded. There were 212 that did not meet inclusion criteria with the main reason being lack of internet (74). Additionally, 123 declined to participate. Of those that met eligibility criteria, 101 were randomized, with 51 allocated to the control group and 50 allocated to the intervention group. All but two selected English to play the game, despite that 50.7% said that Spanish was the primary language spoken at home (Table 3). Of the 50 allocated to the intervention group, eleven parent/child dyads completed at least some game play at home. Of those eleven, four completed all game play and three completed the questionnaire at T2. Two participants did not complete the initial game play with the research assistant. One was notated as not being interested once game play started. The other did not complete because the internet went down at the study site. Follow-up for all 101 participants to complete the T3 questionnaire met with challenges. Of the 101 participants, only three completed the two-month follow-up questionnaire, two in the intervention group and one in the control group.

TABLE III. PRIMARY LANGUAGE SPOKEN AT HOME

Language spoken	Control	Intervention	Total
English	11	9	20
English/Spanish same amount	7	7	14
Spanish	33	34	67

Both the control and intervention groups were comparable/not significantly different in terms of race, gender, primary language spoken at home, highest level of education, parent's age, child's age, and child's BMI. Statistical tests (chi square for categorical and t-test for continuous variables) did not show significant difference in attributes of control and intervention groups ($P>0.05$) for all the following analyses. Note there was no difference in obesity (BMI greater than or equal 30) between the intervention and control group (Table 4).

TABLE IV. PARENTS AGE, CHILD BMI AND AGE

	Group	N	Mean	Std. Dev	Std. error mean	t-test P
Parent Age	intervention	50	37.16	5.7	.813	0.493
	control	51	38.06	7.3	1.02	
Child BMI	intervention	50	21.04	4.8	0.68	0.087
	control	51	22.92	6.0	.84	
Child Age	intervention	50	10.82	2.1	.298	0.420
	control	51	11.16	2.0	.290	

An analysis to compare attributes of the intervention group for those that played some part of the game at home to those that played nothing at home was completed. The analysis showed the groups were not different--not only statistically but also based on general distribution of proportions. Figures 5-7 provide details on the attributes.

Study Group			Home Play		Total	
			Did not play	Played some		
Intervention	Gender	FEMALE	Count	23	6	29
			% within Gender	79.3%	20.7%	100.0%
	MALE	Count	16	5	21	
		% within Gender	76.2%	23.8%	100.0%	
	Total	Count	39	11	50	
		% within Gender	78.0%	22.0%	100.0%	

Fig. 5. Gender – did not play vs. played some at home

Study Group			Home Play		Total	
			Did not play	Played some		
Intervention	Race	All others	Count	20	5	25
			% within Race:	80%	20%	
	White	Count	19	6	25	
		% within Race:	76.0%	24.0%	100.0%	
	Total	Count	39	11	50	
		% within Race:	78.0%	22.0%	100.0%	

Fig. 6. Race – did not play vs. played some at home

Observations made by the research assistant during game play found that parent/child dyads played well/quickly/without issues (23). Some of the parents had trouble reading English (7) and a few patients also had trouble reading (3). The satisfaction survey was given to parents after the initial game play at the recruitment site. Figure 10 shows the number of respondents by satisfaction level. The dark green color indicates highest satisfaction to corresponding question. Figure 8 shows satisfaction level by percent of respondents. Overall, parents were very satisfied with the game play usability and knowledge being conveyed. Also, most would have wanted to see opportunities to play the game again at hospital visits.

Study Group			Home Play		Total	
			Did not play	Played some		
Intervention	Primary Language Spoken At Home	ENGLISH	Count	6	3	9
			%	66.7%	33.3%	100.0%
	ENGLISH/SPANISH SAME AMOUNT	Count	6	1	7	
		%	85.7%	14.3%	100.0%	
	SPANISH	Count	27	7	34	
		%	79.4%	20.6%	100.0%	

Fig. 7. Language spoken – did not play vs. played some at home

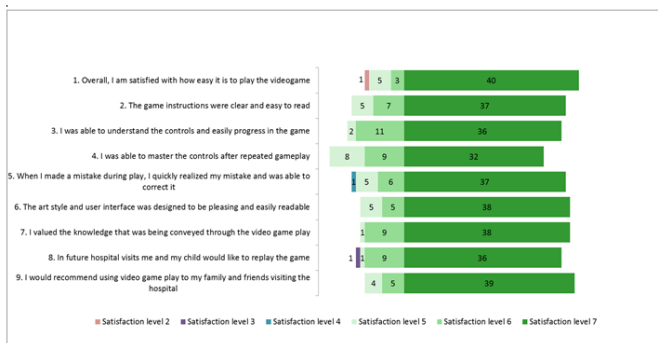


Fig. 8. Satisfaction survey results

VI. CONCLUSIONS

This is the first study where a bilingual videogame intervention was tailored to a specific Latino ethnicity target population group and the videogame was designed for both parent and child play. The pre-videogame assessment survey provided insights into the dietary patterns and attitudes towards food and exercise that are prevalent among Mexican American parents. Based on this information and experience of the clinical research team, the videogame was a tailor made intervention using food choices that were specific to this population. It is increasingly being realized that chronic disease conditions that begin in childhood and factors contributing towards it should be understood from a social and eco-bio-developmental framework. In this conceptual framework, the child is nested within the family micro-system, that thrives within the community and a larger societal ecosystem. Better understanding of this ecosystem is necessary to devise interventions that impact the overall health and well-being of the child.

This study met challenges with the aspect of families completing the game at home. While the study identified families that had internet access at home to complete the game, very few actually did.

Even though the participants were given instructions to login at home and given prizes to complete levels, they did not follow through with it. It is unclear what barrier they faced. It was also surprising all but two participants chose to play the game in English when parents indicated that Spanish was the primary language at home in 50.7% of the intervention group. This indicates the child wanted to select to play the game in English but the parents might have needed Spanish to be able to work together on the game.

In addition, follow-ups for the two-month post recruitment in this population were a challenge, for both the control and intervention. Only three completed the T3 questionnaire. The follow-up process included phone calls made at different times of day and different days of the week, including weekends. In

addition, a letter was mailed to participants. Of the 101 that enrolled in the study, the research assistant was able to speak to the parent at least once in 60 parent/child dyads. The other 40 were either left voice mails or were never reached at numbers provided. Despite contact, parents did not follow through with taking the online post-questionnaire (T3) with their child.

In looking at lessons learned from this study, offering the parent/child dyad the opportunity to play the entire game on site would have increased completion. Any technology barriers they may have faced going home would be removed. On the satisfaction survey, most parents did state they would like to replay the game in future visits. Perhaps supplied with this knowledge, game play could continue at clinic visits using the Family Learning Center to engage families in educational game play. Also seeing how many were assessed for eligibility with no access to internet, the Family Learning Centers provide an avenue to gain access to computers.

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