

Virtual Socialization in Adults With Spina Bifida

Wendy M. Chan, Brad E. Dicianno, MD

Objective: To use spina bifida (SB) as a model of chronic physical disability to study the associations of virtual socialization, friendships, and quality of life (QOL) in adults.

Design: Cross-sectional survey.

Setting: Subjects were recruited from residential living facilities, outpatient clinics, and the University of Pittsburgh Medical Center (UPMC) research registry.

Patients: Inclusion criteria were age between 18 and 80 years and clinical diagnoses of SB cystica (myelomeningocele) and hydrocephalus. The exclusion criterion was the diagnosis of SB occulta. Sixty-three eligible adults were enrolled, and all completed the study.

Methods: The survey via questionnaire was performed in person or over the telephone.

Main Outcome Measurements: Data collected included the World Health Organization's Medical Outcomes Study 26-item Short Form, Economic Self-Sufficiency from the Craig Handicap Assessment and Reporting Technique Short Form, virtual socializing habits, and number of friends. Three linear regression models were performed, each with a unique dependent variable: number of friends, psychological QOL, or social QOL. The following independent variables were included in all models: age, gender, ethnicity, economic self-sufficiency, marital status, education level, lesion level, health status, user group, collection method, and time spent virtually socializing. In addition, each regression model included the dependent variables from the other 2 models in its independent variables.

Results: Increased degree of virtual socialization (VS) was associated with a greater number of friends ($P = .003$, $r = .684$). Mean (standard deviation) numbers of friends by VS groups were the following: users, $n = 4.9 \pm 2.7$; semi-users, $n = 3.8 \pm 2.7$; and nonusers, $n = 2.1 \pm 2.3$, which represent a 2.3 times greater number of friends between the users and nonusers. The effect of virtual socialization on QOL was also positive, however, not statistically significant.

Conclusions: People with chronic physical disabilities, such as SB, are at high risk for peer rejection and long-term social avoidance. Users of the most immersive forms of virtual socialization, have more real world friends than both semi-users and nonusers. Any form of VS, whether immersive or real time, may improve the opportunity for meaningful social encounters. Prospective intervention studies are needed to elucidate whether a causal positive relationship between virtual socialization and friendships exists. Further research is needed to clarify virtual socialization's impact on QOL; however, the upward trend in all 4 domains of QOL across user groups suggests similar potential benefits.

PM R 2011;3:219-225

INTRODUCTION

Having a chronic physical disability affects many aspects of a person's life beyond his or her general health [1]. Myelomeningocele, one form of spina bifida (SB), is commonly associated with hydrocephalus, Chiari II malformation, diminished or absent sensation or motor function in the lower limbs, and impaired bowel and bladder control [2]. Hydrocephalus has also been found to be related to cognitive and behavioral impairments [3].

For several reasons, socialization and relationships with peers may be affected by the cognitive and physical impairments seen in SB. Many people with SB rely on some form of assistive technology for mobility, such as wheelchairs, crutches, or orthoses. Irrespective of the type of assistive technology used, restricted mobility has been linked to poor social integration [4,5]. Executive function, memory, learning, and intelligence quotient (IQ) are

W.M.C. University at Buffalo School of Medicine and Biomedical Sciences, Buffalo, NY. Disclosure: nothing to disclose

B.E.D. Adult Spina Bifida Clinic, Department of Physical Medicine and Rehabilitation, University of Pittsburgh School of Medicine, 201 Kaufmann Building, 3471 5th Avenue, Pittsburgh, PA 152130; VA Pittsburgh HealthCare System, Pittsburgh, PA. Address correspondence to B.E.D.; e-mail: dicianno@pitt.edu Disclosure: 8A, director of the RREMS, which helped fund this study

Disclosure Key can be found on the Table of Contents and at www.pmrjournal.org

This research benefited from the support of Annmarie Kelleher MS, OTR/L, ATP, CCRP, and Stacy Eckstein BS, MT(ASCP) from the Human Engineering Research Laboratories.

Submitted for publication August 10, 2010; accepted December 1.

often impaired in this population [6,7]. Verbal IQ typically remains intact, but, in combination with a subnormal IQ, a disorder known as “cocktail party syndrome” may present. This type of behavior pattern turns language into a “vehicle for social contact rather than an exchange of ideas” [8]. The speaker appears chatty and articulate in conversation although the content of his or her speech is superficial or inappropriate for the context. The etiology of cocktail party syndrome is believed to be due, in part, to parental encouragement and the lack of or inability to perceive negative reinforcement by peers during childhood development [9]. The communication disorders seen in SB can lead to peer rejection and increased risk of psychological and social adjustment problems [10]. Of caretakers of children with developmental disorders, 47.5% reported that their child did not have even one close friend [11]. Holmbeck et al [12] found that the social development difficulties in SB were enduring: children with SB had fewer friends compared with their peers, and this trend continued into adolescence. Peer acceptance in youth is an important predictor of social adjustment in adulthood. Poorly accepted individuals have a higher incidence of criminality, psychopathology, and early termination of education. Results of studies have shown that an association exists between peer acceptance and adult psychopathologic conditions, including conduct disorders, neurosis, schizophrenia, and alcoholism. Criminal records for adults who were classified as poorly accepted children range from 10%-50%, depending on the study and the gender of the child [13]. Dropout rates in poorly accepted girls and boys are 4-5 times greater than their highly accepted peers [14].

In light of the social disadvantages of people with SB, it is not surprising that their social integration level is markedly reduced compared with their able-bodied peers [15]. The reduced social competence and peer social engagement of people with mobility impairments also have been negatively associated with quality of life (QOL) [16]. Children with SB and hydrocephalus were found to have a Child Health Related QOL score one full standard deviation (SD) below children with other disabilities; however, if the children had family and peer support, then QOL was significantly improved [17-19]. Therefore, it is likely that the social integration and QOL score discrepancy between able-bodied people and some people with SB is a secondary effect of their disability and results from a combination of limited positive family support, social isolation, and impaired cognitive abilities.

Exciting advances in immersive technology offer virtual socialization opportunities that may improve the QOL and social integration of people with disabilities. Massively multiplayer online role-playing games (MMORPG), social networking sites, and voice and text chatting programs allow users to interact with others in real time. In virtual worlds such as World of Warcraft (Blizzard Entertainment, Irvine,

CA) and Second Life (Linden Lab, San Francisco, CA), users are able to explore; meet other live players; socialize; participate in individual and group activities, such as quests and raids; and engage in commerce [20,21]. The group raids of the MMORPG World of Warcraft have been described as “phenomenologically intense, emotionally compelling, and deeply connected with self-esteem and group membership” and create “a social solidarity,” and can “serve as an important moment in the biographies of individual players” [22]. The collaboration of players who complete difficult in-game tasks is “highly generative of trust and belonging.” [23]. Currently, research is being conducted at the University of Texas at Dallas Center for Brain Health, to evaluate how patients with Asperger syndrome (AS) respond to social interactions in the online community of Second Life. Preliminary findings indicate that the participants in the program have learned “social appropriateness” and have increased confidence [24]. Elsewhere, such as in the AS Interactive Project funded by the Shirley Foundation, social scenarios in virtual environments are being used by adolescents and adults with AS to teach them social skills relevant to social interaction in public situations [25]. Other forms of virtual socialization include social networking sites such as Facebook and Twitter, which provide a framework for online relationships among people of an individual network. These types of Web sites provide users with tools such as instant messaging, personal profile pages, the ability to “friend” other users or join interest groups, and real-time status updates to share their ideas with other people [26]. Programs like Skype, Ventrilo, and AIM are typically less media-rich tools of virtual socialization that allow users to communicate with specific individuals in real time through combinations of video, voice, or text chats over the Internet. Many newer versions of these programs have features that allow them to be used concurrently with online games or social networking sites to enhance user communication [27].

In this study, we used SB as a model of chronic physical disability to study the associations of virtual socialization, friendships, and QOL in adults. Our decision to examine the adult population was 2-fold. First, the increased life expectancy of patients with SB is a relatively new medical advancement and, as such, necessitates more research that focuses on the increasing number of individuals who are living well into adulthood [28]. Second, the primary outcomes measured in this study are reflective of the individual’s psychosocial development that culminates from years of life experiences. Results of research have shown that personality becomes more clearly defined and stable with increasing age [29]. In this study, we hypothesized that higher degrees of virtual socialization by the user contribute significantly to the number of friends. We also hypothesized that higher degrees of virtual socialization by the user would contribute positively to psychological and social QOL scores.

METHODS

This study was approved by the Institutional Review Board of the University of Pittsburgh. Subjects were recruited from independent living facilities, outpatient clinics, and the University of Pittsburgh Medical Center (UPMC) research registry. Inclusion criteria were age between 18 and 80 years and clinical diagnoses of SB cystica (myelomeningocele) and hydrocephalus. The exclusion criterion was the diagnosis of SB occulta, because functional and cognitive deficits are often minimal. Participants completed a questionnaire in 1 of 2 ways: either over the telephone or during an in-person interview.

The questionnaire contained questions on the participant's background, virtual socializing habits, number of friends, economic self-sufficiency (ESS), health, and QOL. Questions on the participant's background included level of SB, marital status, and education. The items in the virtual socialization section focused on what types, if any, of virtual socialization were used as well as the amount of time engaged in these types of online interactions. The number of friends a participant had was defined as the total number of nonrelative friends that the individual socialized with in a meaningful way either in person, over the telephone, or by mail outside of a business, organizational, or educational setting at least once a month. If the number of friends reported seemed excessively high, then the participant was asked to describe the social settings and types of interactions shared together so that the researcher could help them differentiate friends from associates. Online friendships were not included in this number. ESS was measured by using a domain of the Craig Handicap Assessment and Reporting Technique Short Form, a reporting tool that assesses the extent to which impairments and disabilities result in handicaps. The ESS domain measures the "ability to sustain customary socioeconomic activity and independence" by using an algorithm that examines household income in the context of family size, major medical expenses, and current U.S. poverty guidelines. It should be noted that household income includes outside funding sources, such as disability benefits, charity, and family support. A maximum score of 100 points is possible, which correlates to the typical performance of the average individual without a disability [30]. The health score was derived from the World Health Organization's Medical Outcomes Study 26-item Short Form (WHOQOL-BREF) questionnaire, which asks participants to rate their overall health satisfaction over the past 2 weeks on a 1 (very dissatisfied) to 5 (very satisfied) scale. QOL is a subjective assessment of well-being and reflects the discongruity between a person's present circumstances and the person's hopes and expectations.

A detailed QOL profile was obtained by using the WHOQOL-BREF. This questionnaire examines the individual's perception of their QOL across 4 broad domains: physical health, psychological health, social relationships, and environment in the context of their "culture and value systems,

personal goals, standards and concerns" [31,32]. We were particularly interested in the social and psychological domains of QOL in this study. The social QOL domain explores personal relationships, social support, and sexual activity. The psychological QOL domain examines positive feelings, concentration, self-esteem, body image and appearance, and negative feelings. The raw domain score is calculated by taking the mean of all items in each domain and multiplying it by a factor of 4. This number is then transformed to a 0-100 scale to give the domain score.

We assigned participants to 1 of 3 virtual socialization categories based on their Internet usage habits. We classified nonusers as people who do not use the Internet to engage in any type of real-time socializing (ie, chatting or instant messaging) or immersive digital interactions with other humans (ie, online games or social networking). Nonusers may have contact with the Internet, but their usage is limited to Web browsing or using e-mail. We designated semi-users as people whose online experience included either real-time socializing or immersive digital interactions with others but not both. We classified users as people whose online experience included both real-time socializing and immersive digital interactions with other people.

Statistics

Analyses were conducted by using SPSS (IBM, Somers, NY). The α values were set at .05. We ran 3 linear regression models, each with a unique dependent variable: number of friends, psychological QOL, or social QOL. The following independent variables were included in all models: age, gender, ethnicity, ESS, marital status, education level, lesion level, health status, user group, collection method, and time spent virtually socializing. In addition, each regression model included the dependent variables from the other 2 models in its independent variables. Thus, number of friends, psychological QOL, and social QOL were included as independent variables in the models in which they were not the dependent variable. Means (SD), counts, and percentages for variables were also calculated for each user group.

RESULTS

Data were collected from a total of 63 participants, however, data from 4 participants were excluded because their reported numbers of friendships were considered to be outliers. The mean (SD) number of friendships for all participants was 4.9 ± 6.1 ; the excluded outliers reported more than 1.5 SDs above the mean, and their numbers of friendships ranged from 15-35. Of the 59 included adults, virtual socialization user groups were divided into the following: nonusers, $n = 23$; semi-users, $n = 12$; users, $n = 24$. The average (SD) age was 33.8 ± 9.2 years. Women represented 39.0% of the participants. Two of the participants were Hispanic, and all

the others were white. The mean ESS score was 61.0 ± 25.5 . The majority of participants were single; however, 10.2% were married, and 1.7% were widowed. Of our study population, 67.8% had a high school diploma as their highest level of education obtained, 8.5% did not have a high school diploma or general equivalency degree, 15.2% had their associate's degree, and 8.5% had a bachelor's degree or higher. The median level of SB lesion was at the lumbar level and ranged from thoracic to sacral. The mean (SD) self-reported level of health over the previous 2 weeks in participants was 3.6 ± 1.0 , which corresponds to the rating between neutral (3) and good (4) on the WHOQOL-BREF questionnaire. We conducted 12 of the surveys in person (20.3%); all others were completed over the telephone. In surveys collected over the telephone, the number of friendships had a mean (SD) of 3.7 ± 2.8 . In surveys collected in person, the number of friends had a mean (SD) of 3.0 ± 2.1 . The collection method did not contribute significantly to any of the dependent variables in this study ($P > .05$).

Independent variables, along with their corresponding P values in the regression models, are shown in Table 1. The overall fit of the regression model with number of friends as the dependent variable (Table 2) was significant ($P = .003$, $r = .684$). User group and social QOL were the only independent variables that contributed significantly to number of friends ($P = .027$ and $P < .001$, respectively). The overall fit of the regression model with psychological QOL as the de-

pendent variable (Table 2) was significant ($P < .001$, $r = .761$). Both health status ($P = .006$) and social QOL ($P = .005$) made a significant contribution. The overall fit of the regression model with social QOL as the dependent variable (Table 2) was significant ($P < .001$, $r = .798$). ESS ($P = .031$), number of friends ($P < .001$), and psychological QOL ($P = .005$) also made a significant contribution. Additional statistics from each regression model are shown in Table 2.

DISCUSSION

Our findings supported the hypothesis that higher levels of virtual socialization (VS) contribute positively to number of friends. The mean number of friends for users was 4.9, which was 28.9% higher than for semi-users, who had a mean of 3.8 friends. The average difference between nonusers and semi-users of virtual socialization was more dramatic, from a mean of 2.1 to a mean of 3.8 friends, which represents an 81.0% difference. Overall, the difference in mean number of friends between the users and nonusers was 133%. The likely reason for the more striking difference between nonusers and users is that any form of virtual socialization may improve the opportunity for meaningful social encounters. People with SB may find social interactions difficult in the nonvirtual world due to actual or perceived physical limitations by themselves or by others. Virtual socialization platforms such as Facebook, Second Life, and World of Warcraft can offer people

Table 1. User groups, number of friends, QOL, and baseline demographics

	Nonusers	Semi-users	Users	P value*	P value†	P value‡
N	23	12	24			
Mean (SD) age, y	39.2 ± 8.8	29.5 ± 6.9	30.7 ± 8.2	.135	.571	.066
Women, n, (%)	6 (26.1)	4 (33.3)	13 (54.2)	.710	.429	.843
Non-white, n, (%)	0 (0.0)	1 (8.3)	1 (4.2)	.985	.657	.737
Mean (SD) ESS score	62.8 ± 22.9	59.6 ± 23.0	60.0 ± 30.0	.556	.509	§.031
Married, no. (%)	3 (13.0)	2 (16.7)	1 (4.2)	.538	.934	.834
Median education level (range); % with a high school diploma or higher	HS (6th grade to bachelor's); 82.6	HS (10th grade to bachelor's); 91.7	HS (HS to bachelor's); 100	.471	.951	.339
Median lesion level (range)	Lumbar (thoracic to sacral)	Lumbar (thoracic to sacral)	Lumbar (thoracic to lumbar)	.096	.928	.327
Mean (SD) health score	3.4 ± 1.0	3.4 ± 1.2	3.9 ± 0.8	.956	§.006	.075
Data collected in person, no. (%)	4 (17.4)	1 (8.3)	7 (29.2)	.957	.732	.097
Mean (SD) weekly VS h	0	11.0 ± 10.7	17.9 ± 11.9	.378	.890	.132
Mean (SD) no. friends	2.1 ± 2.3	3.8 ± 2.7	4.9 ± 2.7	—	.059	§<.001
Mean (SD) QOL						
QOL psychological	63.8 ± 17.5	68.1 ± 17.8	75.0 ± 11.3	.059	—	§.005
QOL social	71.4 ± 14.8	74.3 ± 21.5	77.7 ± 13.7	§<.001	§.005	—
User group				§.017	.133	.402

QOL = quality of life; SD = standard deviation; ESS = economic self-sufficiency.

*Values from Friendship analysis.

†Values from Psychological QOL analysis.

‡Values from Social QOL analysis.

§Indicates statistical significance.

Table 2. Regression model statistics

Predictors	Unstandardized β	Standard error	β	<i>t</i>	<i>P</i> value
Dependent variable: friends*					
Age	0.016	0.044	0.056	0.375	.710
Gender	-0.013	0.690	-0.002	-0.019	.985
Ethnicity	-0.535	0.913	-0.072	-0.586	.561
Marital status	0.418	0.673	0.075	0.620	.538
ESS	-0.008	0.013	-0.073	-0.593	.556
Educational level	0.154	0.212	0.089	0.727	.471
Lesion level	1.340	0.787	0.212	1.703	.096
Collection method	-0.047	0.863	-0.007	-0.054	.957
Health status	-0.024	0.431	-0.008	-0.055	.956
Time spent socializing	0.034	0.038	0.149	0.891	.378
Social QOL	0.102	0.027	0.600	3.821	<.001
Psychological QOL	-0.053	0.027	-0.312	-1.941	.059
User group	1.227	0.497	0.408	2.468	.017
<i>r</i>	.684				
<i>R</i> ²	.468				
<i>P</i> value of model	.003				
Dependent variable: psychological QOL†					
Age	-0.131	0.229	-0.075	-0.571	.571
Gender	-2.865	3.586	-0.089	-0.799	.429
Ethnicity	-2.140	4.784	-0.049	-0.447	.657
Marital status	-0.294	3.538	-0.009	-0.083	.934
ESS	0.045	0.068	0.073	0.666	.509
Educational level	0.069	1.116	0.007	0.062	.951
Lesion level	0.387	4.251	0.010	0.091	.928
Collection method	1.557	4.509	0.040	0.345	.732
Health status	5.929	2.076	0.361	2.856	.006
Time spent socializing	-0.028	0.199	-0.021	-0.139	.890
User group	4.137	2.705	0.234	1.530	.133
Friends	-1.455	0.750	-0.247	-1.941	.059
Social QOL	0.438	0.147	0.437	2.975	.005
<i>r</i>	.761				
<i>R</i> ²	.579				
<i>P</i> value of model	<.001				
Dependent variable: social QOL‡					
Age	-0.386	0.205	-0.223	-1.886	.066
Gender	-0.665	3.341	-0.021	-0.199	.843
Ethnicity	1.499	4.433	0.034	0.338	.737
Marital status	-0.692	3.274	-0.021	-0.211	.834
ESS	0.134	0.060	0.216	2.232	.031
Educational level	-0.989	1.023	-0.097	-0.966	.339
Lesion level	-3.858	3.893	-0.104	-0.991	.327
Collection method	-6.867	4.052	-0.176	-1.695	.097
Health status	3.674	2.016	0.224	1.823	.075
Time spent socializing	-0.276	0.180	-0.208	-1.533	.132
Psychological QOL	0.375	0.126	0.376	2.975	.005
User group	-2.156	2.548	-0.122	-0.846	.402
Friends	2.398	0.628	0.408	3.821	<.001
<i>r</i>	.798				
<i>R</i> ²	.637				
<i>P</i> value of model	<.001				

Shaded values are significant *P* values.

ESS = economic self-sufficiency; QOL = quality of life.

*More friends predicted by higher Social QOL and higher forms of virtual socialization.

†Higher Psychological QOL predicted by more friends and higher health status.

‡Higher Social QOL predicted by more friends, higher psychological QOL, and higher ESS.

a safe place to interact with others in a world where there fewer barriers for “being different.” We believe that the difference in number friends seen between semi-users and

users of VS can be explained by the more subtle difference in online experience between these 2 groups. Both the semi-user and user groups had access to a network of other

real people with whom they could freely interact; the user group, however, had the more robust and immersive experience because their online activity typically included an expanded social network and rich multimedia. It is important to note that the time spent virtually socializing did not contribute to the number of friendships, which suggests that any amount of time spent as a user or semi-user may be significant.

The degree of user group was not found to contribute to psychological or social QOL. Although not statistically significant, an upward trend in the 4 domains of QOL was noted across all 3 user groups. Our study population had psychological, social, and environmental QOL domain scores that were similar to the average scores of those in the general population [31,32]. Our data are in agreement with previous studies, which found that most people with SB thought that their overall QOL was on par with their peers [33,34]. The only QOL domain of our participants, mean S.D. (66.1 ± 15.1) to be lower than that of the general population (70.4 ± 14.8) was physical QOL. We reviewed our participant's responses in the QOL physical domain from the WHOQOL-BREF survey and noted that the subjects in our study population had a high reliance on daily medical interventions and were not satisfied with their sleep, mobility, or energy levels. In the Psychological QOL model, perceived health status was a significant contributor. The reported value was fairly high (median of 3.6), particularly in light of the concurrent depressed level of physical QOL expressed by our population. However, our results confirm previous studies that found that people with SB perceive their general health to be good, despite lower scores in many of the objective measurements of health, for example, physical functioning [35], which suggests people with SB may not be the most reliable self-reporters, particularly when asked to quantify their perceptions. There appears to be the tendency for their subjective assessments to be more positive than what the objective measurements indicate. We believe that this euphoric subjectivity may have also contributed to the reported high levels of social and psychological QOL, which makes it difficult to discern if VS had an effect on these variables.

Our study population had an exceptionally low ESS score, which indicates an inability to provide for oneself financially [30]. Many of our participants were either unemployed, underemployed, or out of the work force entirely; and 44.1% lived with parents or siblings. Lower levels of education, transportation difficulties, diminished employment opportunities, social marginalization, and health complications have all been shown to contribute to the increased risk of poverty in people with disabilities [36]. James Weisman, vice president of the United Spinal Association recently reported that the unemployment rate for people with disabilities has remained stable for the last 2 decades, at 65% [37]. According to the Centers for Disease Control and Prevention/National Center for Health Statistics, 23.1% of adults with disabilities

aged 18-44, 41.6% of those aged 45-64, and 34.2% of those 65 years and older experienced work limitations [38]. Interestingly, although one might expect ESS to have an effect on access to technology, the ESS score was relatively stable and low across all user groups, which suggests that users and semi-users had access to these methods of socializing despite limited resources.

Age did show a trend across groups, with the mean age of nonusers being approximately 10 years older than either semi-users or users. The National Telecommunications and Information Administration reports that 37.1% of adults aged 50 years and older access the Internet compared with 63.9% of 24-49 year olds and 65% of 18-24 year olds [39]. Part of this age disparity might be because high-speed Internet was not widely available in this country until the early 1990s. Regardless of the reason for the disparity, age was not strongly correlated with any of the 3 dependent variables in this study.

One limitation of this study was that our definition of a "friend" was fairly detailed and that the number of friends reported was subjective. We tried to control for this by having the same researcher conduct all of the surveys. The researcher would provide participants with verbal clarification to this question. Nonetheless, data from 4 participants were excluded because their reported number of friendships was more than 1.5 SDs away from the mean. We believe that these individuals may have had difficulty differentiating friends from associates. We opted to use the metric of friends contacted in a month to assess social integration skills, primarily because we believed it was more reflective of meaningful social interactions than other more complex measures of social integration that include interactions with other types of people. Solish et al found that although children with SB had few peer interactions outside of school, they were often classified as being socially integrated even though many of their relationships were with family members or caregivers [11]. Although we used the ESS domain of the Craig Handicap Assessment and Reporting Technique Short Form to quantify ESS, we opted not to use the social integration domain of this questionnaire because this test uses the number of family members or caretakers in the calculation of social integration scores. We also wanted to avoid awarding points for nonsubstantial interactions, such as those that occur when being provided with a caregiver service.

CONCLUSION

People with chronic physical disabilities, such as SB, are at high risk for peer rejection and long-term social isolation. Our research is the first we know of to examine friendships and QOL in this population as a function of online socializing habits. Virtual socialization may be a contributing factor to number of friendships, but further research is needed to determine causality. Our research also shows that users of the

most immersive forms of virtual socialization have more real-world friends than do both semi-users and nonusers. For example, we found that participants who engaged in the online world of MMORPGs, such as *Second Life* and *World of Warcraft*, reported nearly twice as many real-world friends as participants who did not use the Internet to virtually socialize. Further research is also needed to clarify virtual socialization's impact on QOL, which was found in this study to show an upward trend in all 4 domains of QOL as degree of virtual socialization increased. At the present time, patients, caretakers, and physicians should recognize virtual socialization as a potentially important tool to advance social inclusion of people with SB.

REFERENCES

1. Eiser C. Children's quality of life measures. *Arch Dis Child* 1997;77:350-354.
2. Kinsman SL, Johnston MV. Congenital anomalies of the central nervous system. In: Kleigman RM, Bherman RE, Jenson HB, eds. *Nelson Textbook of Pediatrics*, 18th ed. Philadelphia, PA: Saunders Elsevier; 2007. Chap 592, p 2452-2455.
3. Del Bigio MR. Neuropathological changes caused by hydrocephalus. *Acta Neuropathol* 1993;85:573-585.
4. Blum RW, Resnick MD, Nelson R, St. Germaine A. Family and peer issues among adolescents with spina bifida and cerebral palsy. *Pediatrics* 1991;88:280-285.
5. Dicianno BE, Gaines A, Collins DM, Lee S. Mobility, assistive technology use, and social integration among adults with spina bifida. *Am J Phys Med Rehabil* 2009;88:533-541.
6. Barf HA, Post MWM, Verhoef M, Jennekens-Schinkel A, Gooskens RHJM, Prevo AJH. Cognitive status in young adults with spina bifida. *Dev Med Child Neurol* 2003;45:813-820.
7. Lindquist B, Persson E, Uvebrant P. Learning, memory, and executive functions in children with hydrocephalus. *Acta Paediatr* 2008;97:596-601.
8. Taylor EM. *Psychological Appraisal of Children with Cerebral Defects*. Cambridge, MA: Harvard University Press; 1961.
9. Tew B. The "cocktail party syndrome" in children with hydrocephalus and spina bifida. *Int J Lang Commun Disord* 1979;14:89-101.
10. Burleson BR, Applegate JL, Burke JA, Clark RA, Delia JG, Kline SL. Communicative correlates of peer acceptance in childhood. *Commun Educ* 1986;35:349-361.
11. Solish A, Minnes P, Kupferschmidt A. Integration of children with developmental disabilities in social activities. *J on Dev Disabilities* 2003;10:115-121.
12. Holmbeck GN, Delucia C, Essner B, et al. Trajectories of psychosocial adjustment in adolescents with spina bifida: a 6-year, four-wave longitudinal follow-up. *J Consult Clin Psychol* 2010;78:511-525.
13. Asher SR, Parker JG. Peer relations and later personal adjustment: are low-accepted children at risk? *Psychol Bull* 1987;102:357-385.
14. Barclay JR. Sociometric choices and teacher ratings as predictors of school dropout. *J Soc Psychol* 1966;4:40-45.
15. Dicianno BE, Gaines A, Collins DM, Lee S. Mobility, assistive technology use, and social integration among adults with spina bifida. *Am J Phys Med Rehabil* 2009;88:533-541.
16. Aliksson-Schmidt AI, Wallander J, Biasini F. Quality of life and resilience in adults with mobility disability. *J Pediatr Psychol* 2007;32:370-379.
17. Cate IM, Kennedy C, Stevenson J. Disability and quality of life in spina bifida and hydrocephalus. *Dev Med Child Neurol* 2002;44:317-322.
18. Kirpalani HM, Parkin PC, Willan AR, et al. Quality of life in spina bifida: importance of parental hope. *Arch Dis Child* 2000;83:293-297.
19. Sawin KJ, Buran CF, Brei TJ, Fastenau PS. Factors associated with quality of life in adolescents with spina bifida. *J Holist Nurs* 2002;20:279-304.
20. Blizzard Entertainment. What is WoW. Available at: <http://www.worldofwarcraft.com/info/basics/guide.html>. Accessed June 16, 2010.
21. Linden Labs. What is Second Life? Available at: <http://secondlife.com/whatis/>. Accessed June 16, 2010.
22. Golub A. Being in the world (of Warcraft): raiding, realism, and knowledge production in a massively multiplayer online game. *Anthropol Q* 2010;83:17-46.
23. Malaby T. Contriving constraints (the gameness of Second Life and the persistence of scarcity). *Innovations: technology, governance, globalization*. 2007;2:62-67.
24. Mangan K. Virtual worlds turn therapeutic for autistic disorders. *Chronical High Educ* 2008;54:26.
25. Cobb S, Beardon L, Eastgate R, et al. Applied virtual environments to support learning of social interaction skills in users with Asperger's syndrome. *Digital Creativity* 2002;13:11-22.
26. Boyd D. Why youth (heart) social network sites: the role of networked publics in teenage social life. In: Buckingham D, ed. *MacArthur Foundation Series on Digital Learning—Youth, Identity, and Digital Media Volume*. Cambridge, MA: MIT Press; 2007:1-26.
27. Shankland S. Facebook Opens Chat, and AIM Plugs In. Available at: http://news.cnet.com/8301-30685_3-20000060-264.html. Accessed June 21, 2010.
28. Davis BE, Daley CM, Shurtleff DB, et al. Long-term survival of individuals with myelomeningocele. *Pediatr Neurosurg* 2005;41:186-191.
29. Capsi A, Roberts B. Personality development across the life course: the argument for change and continuity. *Psychol Inq* 2001;12:49-66.
30. Mellick D. The Craig Handicap Assessment and Reporting Technique. The Center for Outcome Measurement in Brain Injury 2000. Available at: <http://www.tbims.org/combi/chart>. Accessed June 23, 2010.
31. WHOQOL Group. Study protocol for the World Health Organization Project to Develop a Quality of Life assessment instrument (WHOQOL). *Qual Life Res* 1993;2:153-159.
32. Bonomi AE, Patrick, DL, Bushnell, DM, Martin M. Validation of the United States' version of the World Health Organization Quality of Life (WHOQOL) instrument. *J Clin Epidemiol* 2000;53:13-17.
33. Barf HA, Post MWM, Verhoef M, Jennekens-Schinkel A, Gooskens RHJM, Prevo AJH. Life satisfaction of young adults with spina bifida. *Dev Med Child Neurol* 2007;49:458-463.
34. Query JM, Reichelt C, Christoferson LA. Living with chronic illness: a retrospective study of patients shunted for hydrocephalus and their families. *Dev Med Child Neurol* 1990;32:119-128.
35. Verhoef M, Post MWM, van Asbeck FWA, Gooskens RHJM, Prevo AJH. Perceived health in young adults with spina bifida. *Dev Med Child Neurol* 2007;49:192-197.
36. Elwan A. *Poverty and Disability: A Survey of the Literature*, SP Discussion Paper No. 9932. Washington, DC: The World Bank, December 1999.
37. Wood DB. ADA at 20: breakthroughs abound, but some attitudes unchanged. *The Christian Science Monitor* 2010. Available at: www.csmonitor.com/USA/2010/0726/ADA-at-20-breakthroughs-abound-but-some-attitudes-unchanged. Accessed July 28, 2010.
38. Altman B, Bernstein A. *Disability and Health in the United States, 2001-2005*. Hyattsville, MD: National Center for Health Statistics; 2008.
39. Wicks DA. *Building Bridges for Senior: Older Adults and the Digital Divide*. Kent, OH: CAIS/ACSI; 2003;186-196.