Spring 5-2014

Development of a Tool to Assess Children's Perceptions of Their Own Balance (The Pediatric Balance Perception Battery): A Pilot Study

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DEVELOPMENT OF A TOOL TO ASSESS CHILDREN'S PERCEPTIONS OF THEIR OWN BALANCE (THE PEDIATRIC BALANCE PERCEPTION BATTERY): A PILOT STUDY

By

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A doctoral project submitted in partial fulfillment

of the requirements for the

Doctorate of Physical Therapy

Department of Physical Therapy

School of Allied Health Sciences

The Graduate College

University of Nevada, Las Vegas

May 2014

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

THE GRADUATE COLLEGE

We recommend the doctoral project prepared under our supervision by

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entitled

Development of a Tool to Assess Children's Perceptions of Their Own Balance (The Pediatric Balance Perception Battery): A Pilot Study

is approved in partial fulfillment of the requirements for the degree of

Doctor of Physical Therapy
Department of Physical Therapy

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May 2014

Abstract
Background: Psychosocial aspects of balance including self-perception, behaviors, and experiences, have been found to contribute to activity limitations and participation restrictions in adults. Clinical tools have been established to measure how adults feel about their own balance and the extent to which fear of falling and other related characteristics interfere with participation. There are no clinical tools presently available to explore these relationships and quantify the extent to which they interfere with activity and participation in children.

Purpose: To develop and test reliability and validity of a tool to evaluate balance self-perception in a pediatric population.

Participants: This sample of convenience of children (n=12), aged eight-14 years (mean = 10.17±2.08) included children with typical development (n=11) and a child diagnosed with Autism and age appropriate motor skills (n=1).

Methods: A multidisciplinary panel of experts reviewed the Pediatric Balance Perception Battery (PBPB) for face and content validity. The finalized PBPB contained five main sections: balance confidence, fear of falling, consequences of falling, avoidance behavior, and fall catastrophizing. Test-retest reliability was determined by comparing the PBPB scores between two measurements that were performed approximately seven days apart. Construct validity was assessed by associating the PBPB with measures of 1) self-assessment of quality of life, 2) performance-based balance assessment, 3) endurance, and 4) activity level using Spearman's Rank Correlations.

Results: Face and content validity of the PBPB were supported by expert and stakeholder panelists. The PBPB had poor to moderate test-retest reliability (intraclass correlation coefficients: 0.27 - 0.69). Sections of the PBPB were significantly correlated with the Pediatric Quality of Life Inventory Short Form 15 Generic Core Scales (PedQL-SF15), the Pediatric Balance Scale (PBS), and two measures of activity level. Average time to administer the PBPB was 8.65 minutes.

Limitations: The small size and homogeneity of the present sample may limit the generalizability of findings.

Conclusion: The current configuration of the PBPB questionnaire demonstrated acceptable face and content validity in children ages seven to 15 years. Poor to moderate test-retest reliability was found. Sections of the PBPB revealed significant evidence of construct validity with self-assessment of quality of life, performance-based balance assessment, and activity level. However, no evidence was found to support the construct validity of the PBPB in the remaining measures. Future large-scale research would be needed to determine the validity and reliability of this study cohort.

Acknowledgements

We would like to thank the multidisciplinary panel for their assistance in development and establishment of the validity of the PBPB, the UNLV School of Allied Health Sciences Grant, and the UNLV Kids Research Outreach to Community Clinicians (UNLV KidsROCC) for help with recruitment. We would like to recognize the parents and children who participated in the study. Finally, thank you to Dr. Szu-Ping Lee, PhD for his assistance with the statistical analyses.

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Introduction

The Centers for Disease Control and Prevention (CDC)[1] report that falls are the leading cause of non-fatal injuries for all children ages zero to 19 years. Every day, approximately 8,000 children are treated in U.S. emergency rooms for fall-related injuries.[1] This adds up to almost 2.8 million children each year.[1] The CDC[1] also estimated that lifetime medical cost in children ages zero to 19 for non-fatal fall injuries was five billion dollars and the lifetime work lost cost was 10 billion dollars. External factors associated with increased risk of injurious falls in children include bunk beds, stairways, playground equipment, and infant walkers.[2]

Intrinsic factors, such as age, gender, and presence of disability, also play a role in fall occurrence and likelihood of injury.[2,3] Ramirez et al[3] estimated that school-aged children with multiple disabilities were 1.7 times more likely than their typically developing peers to sustain an injury from an accident or fall resulting in possible concussion. Typically developing children were more likely to experience upper limb and overexertion injuries not related to falls.[4]

Not all injuries sustained when a child falls are physical or observable. Children who have experienced a fall and associate this with adverse feelings, are more likely to lose interest in activities and limit their own participation in their daily roles.[5] Participation is defined as the amount of involvement one has in everyday life situations in order to develop important social and physical skills, create meaningful relationships, and achieve a sense of purpose within their environment.[6] Children with decreased participation do not fully engage with their roles in their families, schools, and communities. Participation restrictions are common in children with disabilities and tend to increase as they age.[7] It is plausible that experiences such as falls may contribute to decreased participation in this population.

Numerous possible psychosocial mediators may contribute to decreased activity and participation among children.[8] Lewis et al[9] identified balance self-efficacy, the amount of confidence one has in completing a physical activity in the presence of other environmental factors, as a major mediator of decreased participation. Avoidance behavior and fear may also intervene with

participation.[10] Avoidance behavior can be described as a decrease in certain behaviors (e.g. physical activity) when an individual associates these behaviors with an aversive or painful experience.[11] Fear is an internal state that can be expressed by an individual, verbally or physically, by avoiding certain behaviors.[12] Landers et al[13] found that a precipitating factor of avoidance behavior in adults is a fear of falling. Adults, with various lifelong developmental disorders, who had experienced a childhood injury, demonstrated significantly decreased physical activity due to fear generated by past injuries.[14]

Physical and emotional consequences of falling may also contribute to a decrease in participation. Negative consequences of falling have been attributed to perceived physical harm, permanent disability, social embarrassment, and personal identity.[15] These negative consequences can cause depression and anxiety, which may lead to a decrease in participation and quality of life.[16] Participation is needed to gain social, physical, and behavioral skills that children will need as they enter into adulthood.[6] Children who lack typical mobility or opportunities to engage in social and educational environments are more likely to have developmental problems in these areas as they age.[6]

Many people, including children, may have a fear of falling without experiencing an actual fall; other individuals who have a history of falls may have no fear and high balance confidence.[15] One difference between these two outcomes may be a tendency toward catastrophizing.[17] If a child believes that their pain or physical condition is worse than it actually is, their pain experience and disability may be intensified.[17]

Based on the prevalence of falls and the effect of psychosocial mediators on participation, pain, and disability, we searched the literature from 2012 to 2014 for pediatric tools that assess balance confidence, fear of falling, consequences of falling, avoidance behavior, and fall catastrophizing. Existing pediatric tools focus primarily on quality of life such as the Pediatric Quality of Life Inventory Short Form 15 Generic Core Scales (PedQL-SF15).[18] Quality of life may be affected by psychosocial mediators (i.e. balance confidence, fear of falling, and avoidance behavior); however, this questionnaire tests general aspects of a child's life and does not specifically address

these constructs. There are two commonly used tools in the adult population that measure balance confidence and self-efficacy, these include: the Activities-Specific Balance Confidence Scale (ABC) and the Falls Efficacy Scale (FES).[19] Parallel tools do not currently exist for the pediatric population.

The Fear of Falling Avoidance Behavior Questionnaire (FFABQ) is a tool that has demonstrated evidence of validity and reliable in both a healthy and pathological adult population.[13] The FFABQ study found that there was an increase in reported avoidance behavior in participants with a history of falling.[13] Currently, there are no tools in the literature for children that specifically measure the fear of falling or if it causes avoidance behavior. One tool that quantifies fear in children is the Revised Fear Survey Schedule for Children (FSSC-R).[20] The FSSC-R is a 3-point scale where 1=no fear and 3=a lot of fear.[20] This tool includes one question on fear of falling from high places, but does not capture fear of falling, consequences of falling, avoidance behavior, or fall catastrophizing which may restrict participation.

The purpose of our study was to create an easy to use and reliable tool that would fill this gap by capturing various aspects of balance self-perception in children. The Pediatric Balance Perception Battery (PBPB) was created to be used as an adjunct to existing tools that measure the development of postural control and balance skills and to help clinicians better understand how a child's balance perception may influence their participation. To achieve this purpose, we first sought to establish face and content validity. We then examined test-retest reliability by comparing the PBPB scores of participants between two measurements that were performed approximately a week apart. Finally, construct validity was tested by comparing the PBPB measures with previously established assessment tools, including the Pediatric Balance Scale [PBS],[21] Dynamic Gait Index [DGI],[22] Timed "Up & Go" Test [TUG],[23] 3-Minute Walk Test [3MWT],[24] Limits of Stability test [LOS] measured by the portable BioSway,[25,26] PedQL-SF15,[18] and StepWatch Activity monitors.[27, 28]

Methods

Questionnaire Development and Testing Procedures

The design of the study included questionnaire development and psychometric analysis (see Figure 1). Questionnaire development included an original draft written by two experienced physical therapy researchers and two doctor of physical therapy students. It was reviewed for face and content validity by a panel that included a variety of stakeholders. This revised questionnaire then underwent psychometric testing for reliability and construct validity. This study was approved by the Institutional Review Board (IRB) *. All participants and parents provided written informed consent prior to the study.

Face and Content Validity

Face and content validity of the questionnaire were determined by a panel of 11 experts: six physical therapist educators (all have published research related to pediatrics, balance, and/or falls), seven physical therapists whose specialty was pediatrics, five physical therapists whose specialty was balance, one occupational therapist whose specialty was pediatrics, one occupational therapist educator, and one nurse practitioner who was an expert in balance. They were asked to assess the face validity of the items in the questionnaire and content validity of the questionnaire as a whole. The expert panel was also asked to offer suggestions/comments about the wording of the questionnaire, about question redundancy, and about missing or superfluous items. This process triggered the addition of five additional items, the rewording of the opening instructions, and rewording of several items. All items retained in the final questionnaire, which was then referred to as the PBPB, were deemed to have suitable face and content validity by the expert panel (see Appendix 1).

The PBPB was framed using the International Classification of Functioning, Disability, and Health (ICF) construct (see Appendix 2) and consisted of 34 questionnaire items divided into five perceptual constructs, each under its own subheading: balance confidence, fear of falling, consequences of falling, avoidance behavior, and fall catastrophizing.

* IRB approval number: 1210-4285

The balance confidence construct included eight items that are in the activity/participation domain of the ICF with 5-point likert style responses (absolutely, quite a bit, somewhat, a little bit, not at all). The total score of the balance confidence section comes from adding up all eight items using the following: absolutely (4 points), quite a bit (3 points), somewhat (2 points), a little bit (1 point), and not at all (0 points). Thus, scores from this subsection will range from zero to 32, with high scores being indicative of high balance confidence and low scores being indicative of low balance confidence.

The fear of falling construct included six items that are in the activity/participation domain of the ICF with 5-point likert style responses (never, hardly ever, sometimes, often, and always). The total score of the fear of falling section comes from adding up all six items using the following: never (0 points), hardly ever (1 point), sometimes (2 points), often (3 points), and always (4 points). Thus, scores from this subsection will range from zero to 24, with high scores being indicative of high fear of falling and low scores being indicative of low fear of falling.

The consequence of falling construct included five items that are in the activity/participation domain of the ICF with 5-point likert style responses (never, hardly ever, sometimes, often, and always). The total score of the consequence of falling section comes from adding up all five items using the following: never (0 points), hardly ever (1 point), sometimes (2 points), often (3 points), and always (4 points). Thus, scores from this subsection will range from zero to 20, with high scores being indicative of high consequence of falling and low scores being indicative of low consequence of falling.

The avoidance behavior construct included 15 items that are in the activity/participation domain of the ICF with 5-point likert style responses (never, hardly ever, sometimes, often, and always). The total score of the avoidance behavior section comes from adding up all 15 items using the following: never (0 points), hardly ever (1 point), sometimes (2 points), often (3 points), and always (4 points). Thus, scores from this subsection will range from zero to 60, with high scores

being indicative of high avoidance behavior and low scores being indicative of low avoidance-behavior.

The fall catastrophizing construct included five items that are in the activity/participation domain of the ICF with 2-point likert style responses (true and false). The total score of the fall catastrophizing section comes from adding up all five items using the following: true (1 point) and false (0 points). Thus, scores from this subsection will range from zero to five, with high scores being indicative of high fall catastrophizing and low scores being indicative of low fall catastrophizing.

Questionnaire psychometrics

Participants

Participants were included in the study if they met all of the following criteria: 1) parent permission and child assent, 2) aged seven to 15 years, 3) demonstrated cognition within a normal range on the Mini Mental State Examination (MMSE) by using criteria established for children by Ouvrier et al,[29,30†] 4) independent ambulation with or without an assistive device (see Figure 2). Children were excluded from the study if they failed to meet any of the above or if they had one or more life events (i.e. a fall) between testing times or on testing days (see Figure 2). One goal of subject recruitment was to create a heterogeneous sample of children with a broad range of balance skills. In order to obtain this desired sample, individuals who were typically developing (presumably without balance problems) as well as those with pathologies known to have high prevalence of balance problems (i.e. cerebral palsy (CP), autism spectrum disorder, spina bifida, developmental delay, developmental coordination disorder (DCD)) were the target population. A sample of convenience was recruited using snowball sampling at local physical therapy clinics, support groups, schools, and recreation centers in Las Vegas, Nevada and Salt Lake City, Utah. After exclusion of two participants for life events during testing we subsequently recruited 12 English-speaking

† For children ages seven to nine, the cutoff score will be 22; the cutoff score for children ages 10 to 15 will be 27

individuals (eight boys and four girls) between eight to 14 years of age with a mean age of 10.2 yrs. (SD= 2.1, range= 6). The participant's primary health conditions were as follows: 11 typically developing and one with a diagnosis of Autism with age appropriate motor skills. Participant's demographics are reported in Table 1.

Reliability

Intraclass correlation (ICC) statistics were used to determine test-retest reliability.[31] The PBPB was administered to participants twice, separated by one week. Because the PBPB is a self-report questionnaire, it was felt that a one-week interim would be sufficient time for knowledge decay from the first administration to decrease the potential for a testing effect. The PBPB was timed for calculation of the average time to completion. Test-retest reliability was not performed for a separate group with motor delay because our one subject in this group who was diagnosed with Autism demonstrated age appropriate motor skills. We concluded that it would be best to include this subject with the typically developing group due to this subject's high level of function.

Construct Validity

Evidence for construct validity was determined by using convergent validity with the participants' data from the first administration day. We planned to assess construct validity of the PBPB by looking for associations between the PBPB and established tools measuring similar constructs. This was measured by comparing the PBPB scores to previously established assessment tools, including 1) self-assessment of quality of life questionnaire: PedQL-SF15 (Table 2), 2) performance-based balance assessment tools: PBS, DGI, Biodex BioSway Balance System[‡] LOS, TUG (Table 3), 3) endurance: 3 minute walk test (Table 4), and 4) activity level measures (Table 4).

Activity levels were measured using a StepWatch Activity Monitor (SAM).[27§] These devices are small portable accelerometers that also track steps. Participants were instructed to secure the device to their right leg just above the lateral malleolus and to wear it daily taking it off at night or for

[‡] Biodex Medical Systems, Shirley, NY, USA
[§] Cyma Corp., Mountlake Terrace, WA, USA

water activities. For each subject, the SAM was calibrated according to the manufacturer's recommendations and collected the following data; average steps per day, average percent in no activity, average percent in total activity, average percent in minimum activity, average percent in medium activity, average percent in high activity, average steps during low activity, average steps during medium activity, average steps during high activity, ratio of low steps to medium steps, ratio of low steps to high steps, ratio of medium steps to high steps, and peak index. The activity levels were reported as low (fewer than 15 steps per minute), medium (15 to 42 steps per minute), or high (more than 42 steps per minute).[32] StepWatch malfunction was manifested in two of our 12 participants. One of these was performed again on a different week and the other subject refused to wear it for an additional week.

Statistical Analyses

Intraclass correlation coefficient (ICC) model 3,1 was used for test-retest reliability.[31] For the ICC values, reliability was defined as good (> 0.75), moderate (0.5-0.75), and poor (< 0.5).[33] Due to the limited number of participants, normality could not be assumed; therefore, non-parametric correlations (Spearman's Rank Correlations) were used to examine the association between PBPB constructs and the PBS, DGI, TUG, 3-Minute Walk Test, LOS test measured by the portable BioSway, PedQL-SF15, and StepWatch Activity monitors. All statistical analyses were performed on SPSS 19.0 statistical software, using a significance level of 0.05.[31**]

Results

Reliability

ICC statistics[31] for each section of the PBPB are shown in Table 5. Each construct is as follows: balance confidence had moderate reliability (ICC [3,1] = 0.524, 95% confidence interval (CI) = (-).040 – .835); fear of falling had moderate reliability (ICC [3,1] = 0.690, 95% CI =.222 - .900); consequences of falling had poor reliability (ICC [3,1] = 0.272, 95% CI =(-).330 - .717); avoidance behavior had poor reliability (ICC [3,1] = 0.408, 95% CI =(-).187 - .784). The fall

** International Business Machines Corp., Armonk, NY, USA

catastrophizing construct was not analyzed because there were only two choices and the group was too homogenous in their answers. Average time to administer the PBPB to participants was 8.65 minutes (SD = 3.88, range = 4.38-19.11).

Construct Validity Analysis

Table 6 contains the correlation statistics for the relationships of the PBPB to the performance-based balance assessment measures (i.e. PBS, DGI, TUG and LOS), self-assessment of quality of life (PedQL-SF15), and endurance and activity level measures (i.e., 3MWT and activity monitor results).[31] The PBPB balance confidence section had a significant moderate negative correlation with the ratio of medium steps to high steps on the activity monitors ($r=-0.607$, $p=<0.05$). The PBPB consequences of falling section had a significant moderate negative correlation with the PedQL-SF15 questionnaire ($r=-0.621$, $p=<0.05$). The PBPB avoidance behavior section had a significant moderate positive correlation with the average of low steps taken on the activity monitors ($r=0.615$, $p=<0.05$). The PBPB fall catastrophizing section had a significant moderate negative correlation with the PedQL-SF15 ($r=-0.603$, $p=<0.05$) and the PBS ($r=-0.620$, $p=<0.05$). No significant correlations were noted between any section of the PBPB and the DGI, TUG, LOS, 3MWT and activity measures ($p>0.05$).

The fear of falling, consequences of falling, avoidance behavior, and fall catastrophizing sections demonstrated poor negative correlations with the PedsQL-SF15 and all measures of performance based balance assessment but these values were not statistically significant ($r=-0.018$ to $r=-0.435$). The fear of falling, consequences of falling, avoidance behavior, and fall catastrophizing sections demonstrated poor negative correlations with average percent of time spent in high activity but were also not statistically significant ($r=-0.005$ to $r=-0.180$).

Discussion

The PBPB demonstrated good face and content validity, showing that according to experts this tool represents the content it is testing. Average time to administer the PBPB to children with typical development was 8.65 minutes, indicating that this test was easy to administer and could be

finished in a timely manner. Overall, our data demonstrated poor to moderate test-retest reliability with lowest ICC in consequences of falling (0.27) and highest ICC in fear of falling (0.69). Sections of the PBPB were significantly correlated with the PedQL-SF15, PBS, and two measures of activity levels, revealing evidence of construct validity in self-assessment of quality of life, performance-based balance assessment, and activity level. However, no evidence was found to support the construct validity of the PBPB in the remaining measures.

The balance confidence and fear of falling sections performed best, demonstrating moderate reliability. The other three sections of the PBPB (consequences of falling, avoidance behavior, and fall catastrophizing) demonstrated poor reliability. These findings may be due to the small and homogenous sample size. All but one participant, who was a child diagnosed with autism and age appropriate motor skills, were typically developing. A broader and more clinically relevant sample is needed.

The validity of the PBPB constructs was supported by the results of the correlation statistics, indicating promising results. There was a significant moderate negative correlation between the PBPB's balance confidence construct and the ratio of medium to high amount of steps. This may suggest that participants with higher balance confidence spend more time in high intensity activity than medium intensity activity. The consequences of falling and fall catastrophizing constructs had a significant moderate negative correlation with the PedQL-SF15. This may be explained by the observation that children who are less worried about the consequences of falling have a greater quality of life. The fall catastrophizing construct also had a significant moderate negative correlation with the PBS, which may suggest that children with a tendency toward catastrophizing demonstrate decreased balance performance. Finally, the avoidance behavior construct had a significant moderate positive correlation with the average of low steps taken. This result may indicate that children who avoid participating in certain behaviors may have a lower activity level.

In addition to the significant correlations identified, there were some interesting findings that were not significant. The fear of falling, consequences of falling, avoidance behavior, and fall

catastrophizing sections all demonstrated poor negative correlations with the PedsQL-SF15 and all measures of performance based balance assessment. This may suggest that children with decreased balance perceptions demonstrate a decreased quality of life and decreased balance performance. Another measure that was insignificant but interesting was the average percent of time spent in high activity. The fear of falling, consequences of falling, avoidance behavior, and fall catastrophizing sections demonstrated poor negative correlations with average percent of time spent in high activity. This may suggest that children with decreased balance perception demonstrate less time participating at higher activity levels.

The significant correlations identified in this study were consistent with the literature on balance confidence, consequences of falling, and avoidance behavior in adults.[13] This may suggest that the balance perception of children is similar to adults with disabilities. However, while our tool was intended for use in clinical populations, our sample mostly included children with typical development. It is possible these associations may not hold true for children with disabilities. Looking at this information in children with motor delay or disability may give us a better idea of how balance perception in children with disabilities compares to that of other children or of adults with disabilities. According to Bjornson et al[34] children with CP have a lack of variability in movement and activity in general. If we obtained participants with CP, we would have expected their activity levels to be lower than a typically developing child and this may be true for children with other types of motor delay as well.

Interestingly, the average number of steps per day in our sample was 7,122 for ages eight-14 (Table 7a), 7,894 for ages eight-11 (Table 7b), and 4,804 for ages 12 to 14 (Table 7c). Current reported values estimate that the average child aged six to 11 years should take between 8,500 and 13,500 steps per day and that the average adolescent aged 12 to 17 should take between 10,500 to 14,000 steps per day.[35] These numbers describe active children who attained 60 minutes or more of moderate to vigorous activity per day. This is a large deviation from what our study found, which may be a function of environment or small sample size. The majority of our participants might have

been in the lower end of activity level and we might not have gotten enough participants in the higher end of activity level to balance this out. This could be due to many factors that we did not record like how much travel time they experienced or how much sleep they got during the testing week. We also did not collect data about what their activities consisted of during the week or if they had any sports obligations.

A limitation of the PBPB may be due to a function of the tool's construction or verbiage. The expert panel had commented on how this type of tool was needed for the pediatric population, but was not sure if the PBPB was going to be understood by children. The wording of certain questions may be too abstract for young children and they may not have understood what was asked of them. The wording of the first question in the balance confidence section was difficult for the younger children to understand. The way the wording included "will not lose your balance" along with the likert scale including "absolutely" as having the best balance was confusing for younger children (ages eight-nine). The fourth question in the fear of falling section was also confusing for the participants because they seemed to imagine a high place as being a mountaintop. This question should be changed to explain something high as in a counter top or something else that is not so extreme. There was also a learning curve for those administering the test and there may have been a learning curve for those taking the test. The researchers had the greatest difficulty clarifying the balance confidence section of the questionnaire. More extensive analysis is needed of the questions in the PBPB.

Another source of error in the study may reside in equipment used for measurement purposes. The BioSway device worked well in children who weighed approximately 60 pounds, but was inaccurate in children who did not. In participants weighing less than 60 pounds, the cursor on the BioSway device would stop moving and get stuck, indicating decreased or no detection of the participant's movements. This was an unanticipated problem that resulted in inaccurate and missing data. The number of participants with inaccurate data is unclear due to not including weight measurements as part of our protocol.

Based on the results from this study we continue to hypothesize that if therapists can better understand factors that underlie children's participation restrictions, clinicians and families will be better equipped to meet the needs of children with altered balance perception and find ways to overcome avoidance behaviors that can restrict participation. The need for tools like the PBPB was supported by the study, as was the need to make it more understandable and child-friendly.

Conclusion

The PBPB questionnaire is the first assessment tool that assesses balance confidence, fear of falling, consequences of falling, avoidance behavior, and fall catastrophizing in children. The current configuration of the PBPB questionnaire demonstrated acceptable face and content validity in children ages seven to 15 years; however, poor to moderate test-retest reliability was found. Sections of the PBPB were significantly correlated with PedQL-SF15, PBS, and two measures of activity levels, revealing evidence of construct validity in self-assessment of quality of life, performance-based balance assessment, and activity level. However, no evidence was found to support the construct validity of the PBPB in the remaining measures. In addition, future large-scale research would be needed to examine the reliability and validity.

Table 1. Participants' demographics

	Number of Participants
Age in Years	
- 8	4

- 9	1
- 10	2
- 11	2
- 12	1
- 13	1
- 14	1
Gender	
- Male	8
- Female	4
Ethnicity	
- Non-Hispanic	12
- Hispanic	0
Race	
- White	10
- Black or African American	2
Body Type	
- Ectomorph	7
- Mesomorph	3
- Endomorph	2

Table 2. Self-assessed perception of quality of life

Standardized Test	Construct	No. of Items	Evidence for Reliability	Evidence for Validity

PedQL -SF15[18]	Clinician-rated assessment of self-report or parent-proxy assessment of quality of life	Four Scales: (1) Physical Functioning (5 items) (2) Emotional Functioning (4 items) (3) Social Functioning (3 items) (4) School Functioning (3 items) Items are reverse-scored and linearly transformed to a 0–100 scale (0 = 100, 1 = 75, 2 = 50, 3 = 25, 4 = 0), so that higher scores indicate better HRQOL. Scale Scores are computed as the sum of the items divided by the number of items answered (this accounts for missing data). If more than 50% of the items in the scale are missing, the Scale Score is not computed	0.88 Child Self-Report; 0.90 Parent Proxy-Report[18]	Valid in ages 2-18, self-report and parent-proxy. Valid in healthy, acute and chronic conditions.[18]

Table 3. Performance-based balance assessment tools

Standardized Scale	Construct	No. of Items	Evidence for Reliability	Evidence for Validity

Pediatric Balance Scale[21]	Clinician-rated assessment of balance tasks	14 task, total score 0 (maximum fall risk) to 56 (least fall risk)	ICC = 0.998[21]	Valid for ages 5- 15 and populations that have Prader-Willi syndrome, learning disabled and speech-language impaired, mental retardation, spina bifida, status post-brain tumor resection, cerebral palsy, athetoid, hemiplegia, hypotonia, spastic diplegia[21]
Dynamic Gait Index[22]	Clinician-rated assessment of ability to modify gait under various conditions	Eight tasks, total score ranging from 0 (greatest fall risk) to 24 (lowest fall risk)	ICC = 0.71[22]	Valid for ages 8 – 15 yrs., and for populations that are typically developing or have fetal alcohol spectrum disorder[22]
Biodex BioSway Balance System LOS[26, 36]	Portable balance measurement device with adjustable, computerized platform	Eight directions holding 0.25 seconds each. One test.	ICC = 0.81[26]	Used in a child with Down Syndrome the age of 12[36]
Timed "Up & Go" Test[23]	A timed test of functional mobility	Three components (sit to stand, walk, sit down)	ICC = 0.83[23]	Reliable for children without disability 3-9 yrs., and with disability 3-19 yrs. TUG mean children w/o disabilities 5.9 s[23]

ICC= intraclass correlation coefficient, N/A = not applicable

Table 4. Endurance and activity level measures

Standardized Scale	Construct	No. of Items	Evidence for Reliability	Evidence for Validity
Three Minute	A timed test of	N/A	ICC = 0.94[24]	Reliable for

Walk Test[24]	functional exercise capacity where person walks as far as possible in six minutes			healthy children age 3-18 yrs.[24]
StepWatch Activity Monitor[27, 28]	Device that measures activity levels for a week period	Average steps per day (low, medium, high). Average percent of total activity.	99.87% accuracy, correlations of 0.97 and 0.96 compared to observed steps[27, 28]	Reliable for healthy children age 6-20 yrs.[27]

ICC= intraclass correlation coefficient, N/A = not applicable

Table 5. Intraclass correlation coefficient [ICC (3,1)] of the Pediatric Balance Perception Battery constructs

Section	ICC Value	CI
Balance confidence	0.524	-0.040 - 0.835
Fear of falling	0.690	0.222 - 0.900

Consequences of falling	0.272	-0.330 - 0.717
Avoidance behavior	0.408	-0.187 - 0.784
Fall catastrophizing	-	-

ICC = Intraclass Correlation Coefficient; CI = Confidence Interval

Table 6. Correlation statistics of the Pediatric Balance Perception Battery with other measures of quality of life, balance and activity

	Balance Confidence	**Fear of Falling**	**Consequences of Falling**	**Avoidance Behavior**	**Fall Catastrophizing**

Self-assessment of Quality of Life					
- PedQL-SF15	.284	-.472	-.621*	-.445	-.603*
Performance-based balance assessment tools					
- Pediatric Balance Scale	-.033	-.393	-.229	-.329	-.620*
- Dynamic Gait Index	-.086	-.389	-.084	-.061	-.446
- Timed Up and Go	.317	-.018	-.435	-.274	.050
- BioSway Limits of Stability	-.397	-.304	-.102	-.252	-.209
Endurance and activity level measures					
- Three minute Walk Test in Meters	-.092	.034	.370	.046	.172
- Average steps per day	-.314	.124	.360	.334	.151
- Average percent no activity	.363	-.004	-.300	-.348	-.008
- Average percent total activity	-.363	.004	.300	.348	.008
- Average percent minimal activity	-.286	-.007	.501	.466	.080
- Average percent medium activity	-.494	.343	.431	.433	.293
- Average percent high activity	.149	-.167	-.005	-.048	-.180
- Average steps low	-.353	.106	.459	.615*	.142
- Average steps medium	-.494	.343	.431	.433	.293
- Average steps high	.229	-.223	.021	-.078	-.209
- Ratio low step to medium steps	.258	-.099	-.195	-.005	-.205
- Ratio low steps to high steps	-.384	.227	.261	.391	.209
- Ratio medium steps to high steps	-.607*	.566	.421	.540	.527
- Peak index	.289	-.382	-.110	-.163	-.426

*= significance p <0.05

Table 7a: Average steps per day: aged 8-14 years

Participant Number	Number of Days Included	Average Steps Per Day
1	5	8,959.0
2	7	7,169.3
3	6	3,675.0

4	5	7,207.8
6	6	7,083.0
7	6	8,817.0
8	4	5,822.0
10	7	8,925.0
11	7	7,583.0
12	6	9,787.0
13	6	6,782.0
14	1	3,654.0
Average:	**5.5**	**7,122**

Table 7b: Average steps per day: aged 8-11 years

Participant Number	Number of Days Included	Average Steps Per Day
1	5	8,959.0
2	7	7,169.3
4	5	7,207.8

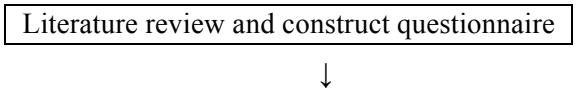
7	6	8,817.0
8	4	5,822.0
10	7	8,925.0
11	7	7,583.0
12	6	9,787.0
13	6	6,782.0
Average:	**5.89**	**7,894.68**

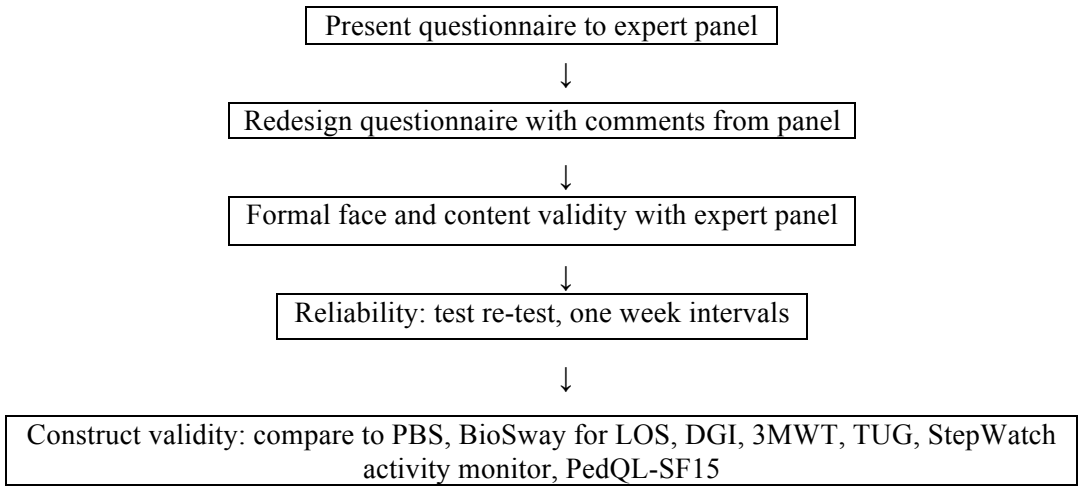
Table 7c: Average steps per day: aged 12-14 years

Participant Number	Number of Days Included	Average Steps Per Day
3	6	3,675.0
6	6	7,083.0
14	1	3,654.0

Average:	**4.33**	**4,804.00**

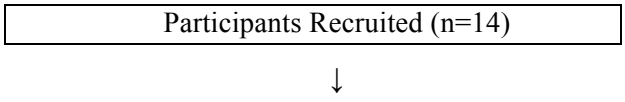
Figure 1. Process of development and analysis of the Pediatric Balance Perception Battery

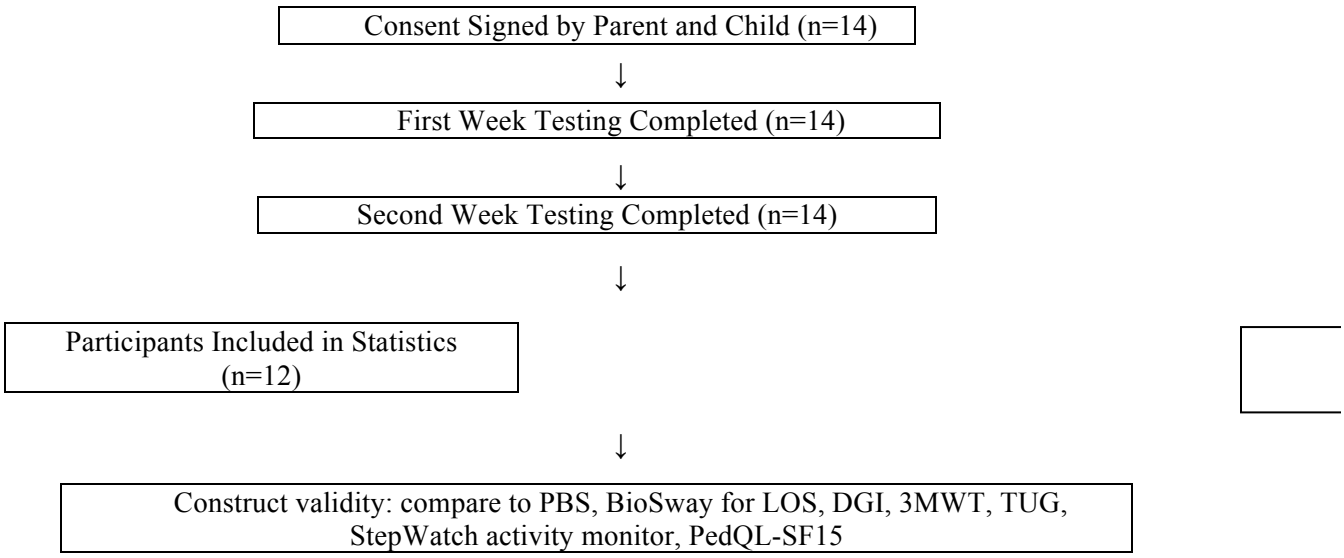




* DGI = Dynamic Gait Index; LOS = Limits of Stability; PBS= Pediatric Balance Scale; PedQL-SF15 = Pediatric Quality of Life Short Form 15; TUG = Timed Up and Go; 3MWT = Three Minute Walk Test

Figure 2. Process of inclusion and exclusion for statistics for the Pediatric Balance Perception Battery





* DGI = Dynamic Gait Index; LOS = Limits of Stability; PBS= Pediatric Balance Scale; PedQL-SF15 = Pediatric Quality of Life Short Form 15; TUG = Timed Up and Go; 3MWT = Three Minute Walk Test

Appendix 1: The Pediatric Balance Perception Battery

Pediatric Balance Perception Battery (PBPB)

Child's name:
Date:

Interviewer:
Interviewee/s:
☐ Child ☐ Parent ☐ Parent and child
Assistive devices (please check all that apply):
☐ Orthotic/Brace ☐ Walker ☐ Crutches ☐ Other:

Interviewer instructions:
This structured interview questionnaire is intended for use with children aged 7 to 15. Please direct all of your questions to the child and read aloud only the italicized narrative. Please read the stem with each item. Do not read the shaded subtitles.

All of the following questions are related to your thoughts and feelings about your balance. If you do not do any of the following things please think about what it would be like to do them. If you have questions about anything, please ask.

Balance confidence:
How sure are you that you will not lose your balance or fall when you...

	Absolutely	*Quite a bit*	*Somewhat*	*A little bit*	*Not at all*
Walk around in your home	☐	☐	☐	☐	☐
Walk around outside on grass	☐	☐	☐	☐	☐
Walk in a crowded area	☐	☐	☐	☐	☐
Run and play outside	☐	☐	☐	☐	☐
Go up and down stairs	☐	☐	☐	☐	☐
Carry a large book or ball with both hands	☐	☐	☐	☐	☐
Carry a glass of water	☐	☐	☐	☐	☐
Stay standing when someone bumps into you	☐	☐	☐	☐	☐

Fear of falling:
I *am afraid that I might fall when I…*

	Never (0% of the time)	*Hardly ever (25% of the time)*	*Sometimes (50% of the time)*	*Often (75% of the time)*	*Always (100% of the time)*

Walk	☐	☐	☐	☐	☐
Go up and down stairs	☐	☐	☐	☐	☐
Pick something up from the floor	☐	☐	☐	☐	☐
Climb up on something high	☐	☐	☐	☐	☐
Exercise	☐	☐	☐	☐	☐
Play outside	☐	☐	☐	☐	☐

Consequences of falling:
I am afraid to fall because…

	Never (0% of the time)	***Hardly ever (25% of the time)***	***Sometimes (50% of the time)***	***Often (75% of the time)***	***Always (100% of the time)***
I might not be able to get back up	☐	☐	☐	☐	☐
I might get hurt	☐	☐	☐	☐	☐
I might be embarrassed	☐	☐	☐	☐	☐
People might make fun of me	☐	☐	☐	☐	☐
I might not be allowed to do things that I like to do	☐	☐	☐	☐	☐

Avoidance behavior:
Because I am scared to fall, I try not to…

	Never (0% of the time)	***Hardly ever (25% of the time)***	***Sometimes (50% of the time)***	***Often (75% of the time)***	***Always (100% of the time)***

Walk	☐	☐	☐	☐	☐
Walk when it is dark or the lights are off	☐	☐	☐	☐	☐
Walk on slippery, wet or icy ground	☐	☐	☐	☐	☐
Go up and down stairs	☐	☐	☐	☐	☐
Run, skip or hop	☐	☐	☐	☐	☐
Get in and out of the car by myself	☐	☐	☐	☐	☐
Climb on things to get something out of a cupboard or off a shelf	☐	☐	☐	☐	☐
Get in and out of bath or shower by myself	☐	☐	☐	☐	☐
Get dressed or undressed by myself	☐	☐	☐	☐	☐
Use the bathroom by myself	☐	☐	☐	☐	☐
Do chores around the house	☐	☐	☐	☐	☐
Exercise	☐	☐	☐	☐	☐
Play team sports	☐	☐	☐	☐	☐
Play with friends	☐	☐	☐	☐	☐
Go out of my house with family or friends	☐	☐	☐	☐	☐

Fall catastrophizing:

	True	***False***
It is really not safe for someone like me to be physically active	☐	☐

I worry a lot about falling	☐	☐
There is nothing I can do to keep myself from falling	☐	☐
I wonder if something really bad might happen if I fall	☐	☐
I keep thinking about how much it might hurt if I fall	☐	☐

Balance Confidence	Fear of Falling	Consequences of Falling	Avoidance Behavior	Fall Catastrophizing
____/32	___/24	____/20	____/60	___/5

Appendix 2: International Classification of Functioning, Disability and Health (ICF) Information matrix domain codes for each of the Pediatric Balance Perception Battery constructs

Item No.	Sections	ICF Information Matrix Domain Codes
	Balance Confidence: How sure are you that you will not lose your balance or fall when you…	
1	- Walk around in your home	Walking (d450) Moving around (d455) Moving around in different locations (d460)
2	- Walk around outside on grass	Walking (d450) Moving around (d455) Moving around in different locations (d460)
3	- Walk in a crowded area	Walking (d450) Moving around (d455) Moving around in different locations (d460)
4	- Run and play outside	Walking (d450) Lifting and carrying objects (d430) Moving around (d455) Moving around in different locations (d460) Recreation and leisure (d920)
5	- Go up and down stairs	Moving around (d455) Moving around in different locations (d460)
6	- Carry a large book or ball with both hands	Walking (d450) Lifting and carrying objects (d430) Moving around (d455) Doing housework (d640) Recreation and leisure (d920)
7	- Carry a glass of water	Walking (d450) Lifting and carrying objects (d430) Moving around (d455) Moving around in different locations (d460)
8	- Stay standing when someone bumps into you	Involuntary movement reaction functions (b755) Control of voluntary movement functions (b760) Maintaining a body position (d415)
	Fear of Falling: I am afraid that I might fall when I…	
1	- Walk	Walking (d450) Moving around (d455) Moving around in different locations (d460)
2	- Go up and down stairs	Moving around (d455) Moving around in different locations (d460)
3	- Pick something up from the floor	Lifting and carrying objects (d430) Doing housework (d640)
4	- Climb up on something high	Moving around (d455) Moving around in different locations (d460) Changing basic body position (d410)
5	- Exercise	Walking (d450) Lifting and carrying objects (d430) Moving around (d455)

		Moving around in different locations (d460) Changing basic body position (d410) Looking after one's health (d570) Exercise tolerance functions (b455) Locations (d460) Recreation and leisure (d920)
6	- Play outside	Walking (d450) Lifting and carrying objects (d430) Moving around (d455) Moving around in different locations (d460) Changing basic body position (d410) Looking after one's health (d570) Recreation and leisure (d920) Exercise tolerance functions (b455) Moving objects with lower extremities (d435) Hand and arm use (d445) Community life (d910)
	Consequences of Falling: I am afraid to fall because…	
1	- I might not be able to get back up	Changing basic body position (d410) Looking after one's health (d570) Psychomotor function (b147) Thought functions (b160) High-level cognitive functions (b164)- specifically insight, judgment, and problem-solving (b1644, b1645, b1646) Experience of self and time functions (b180) Handling stress and other psychological demands (d240)
2	- I might get hurt	Looking after one's health (d570) Emotional function (b152) Thought functions (b160) High-level cognitive functions (b164)- specifically insight, judgment, and problem-solving (b1644, b1645, b1646) Experience of self and time functions (b180)
3	- I might be embarrassed	Looking after one's health (d570) Emotional function (b152) Appropriateness of emotion (b1520) Thought functions (b160) High-level cognitive functions (b164)- specifically insight, judgment, and problem-solving (b1644, b1645, b1646) Experience of self and time functions (b180) Basic interpersonal interactions (d710) Community life (d910) Individual attitudes (e410,415,420,425,430,440,445,450,455,460,465)- attitudes, unspecific (e499)
4	- People might make fun of	Looking after one's health (d570)

	me	Emotional function (b152) Thought functions (b160) High-level cognitive functions (b164)- specifically insight, judgment, and problem-solving (b1644, b1645, b1646) Experience of self and time functions (b180) Basic interpersonal interactions (d710) Community life (d910) Individual attitudes (e410,415,420,425,430,440,445,450,455,460,465)-attitudes, unspecific (e499)
5	- I might not be allowed to do things that I like to do	Emotional function (b152) Motivation (b1301) Thought functions (b160) High-level cognitive functions (b164)- specifically insight, judgment, and problem-solving (b1644, b1645, b1646) Experience of self and time functions (b180) Handling stress and other psychological demands (d240) Basic interpersonal interactions (d710) Family relationships (d760) Community life (d910) Recreation and leisure (d920) – socializing Individual attitudes (e410,415,420,425,430,440,445,450,455,460,465)-attitudes, unspecific (e499)
	Avoidance Behavior: Because I am scared to fall, I try not to…	
1	- Walk	Walking (d450) Moving around (d455) Moving around in different locations (d460)
2	- Walk when it is dark or the lights are off	Walking (d450) Moving around (d455) Moving around in different locations (d460) Products and technology for personal use in daily living(e115) Visual acuity functions (b2100)
3	- Walk on slippery, wet or icy ground	Walking (d450) Moving around (d455) Moving around in different locations (d460)
4	- Go up and down stairs	Walking (d450) Moving around (d455) Moving around in different locations (d460)
5	- Run, skip or hop	Moving around (d455) Recreation and leisure (d920)
6	- Get in and out of the car by myself	Moving around (d455) Moving around in different locations (d460) Changing basic body position (d410)
7	- Climb on things to get	Moving around (d455)

	something out of a cupboard or off a shelf	Moving around in different locations (d460) Changing basic body position (d410) Preparing meals (d630) Doing housework (d640) Lifting and carrying objects (d430) Hand and arm use (d445)- reaching
8	- Get in and out of bath or shower by myself	Moving around (d455) Moving around in different locations (d460) Changing basic body position (d410) Washing oneself (d510)
9	- Get dressed or undressed by myself	Moving around (d455) Changing basic body position (d410) Dressing (d540)
10	- Use the bathroom by myself	Moving around (d455) Changing basic body position (d410) Washing oneself (d510) Toileting (d530)
11	- Do chores around the house	Walking (d450) Moving around (d455) Moving around in different locations (d460) Products and technology for personal use in daily living (e115) Preparing meals (d630) Doing housework (d640) Carrying out daily routine (d230) Lifting and carrying objects (d430)
12	- Exercise	Walking (d450) Recreation and leisure (d920) Lifting and carrying objects (d430) Moving around (d455) Moving around in different locations (d460) Changing basic body position (d410) Looking after one's health (d570) Exercise tolerance functions (b455) Hand and arm use (d445)
13	- Play team sports	Walking (d450) Lifting and carrying objects (d430) Moving around (d455) Moving around in different locations (d460) Changing basic body position (d410) Recreation and leisure (d920) Exercise tolerance functions (b455) Moving objects with lower extremities (d435)- kicking Hand and arm use (d445) Community life (d910)
14	- Play with friends	Walking (d450) Lifting and carrying objects (d430) Moving around (d455) Moving around in different locations (d460) Changing basic body position (d410)

		Looking after one's health (d570) Recreation and leisure (d920) Exercise tolerance functions (b455) Carrying out daily routine (d230) Moving objects with lower extremities (d435) Hand and arm use (d445) Community life (d910)
15	- Go out of my house with family or friends	Walking (d450) Moving around (d455) Moving around in different locations (d460) Recreation and leisure (d920) Community life (d910)
	Fall Catastrophizing:	
1	- It is really not safe for someone like me to be physically active	Walking (d450) Moving around (d455) Looking after one's health (d570) Psychomotor functions (b147) Thought functions (b160) Emotional function (b152) Motivation (b1301) High-level cognitive functions (b164)- specifically insight, judgment, and problem-solving (b1644, b1645, b1646) Experience of self and time functions (b180) Exercise tolerance functions (b455) Sensation of pain (b280)
2	- I worry a lot about falling	Walking (d450) Looking after one's health (d570) Psychomotor functions (b147) Emotional function (b152) Thought functions (b160) High-level cognitive functions (b164)- specifically insight, judgment, and problem-solving (b1644, b1645, b1646) Experience of self and time functions (b180) Maintaining a body position (d415)
3	- There is nothing I can do to keep myself from falling	Psychomotor functions (b147) Emotional function (b152) Thought functions (b160) High-level cognitive functions (b164)- specifically insight, judgment, and problem-solving (b1644, b1645, b1646) Experience of self and time functions (b180) Stability of joint functions (b715) Control of voluntary movement functions (b760) Maintaining a body position (d415)
4	- I wonder if something really bad might happen if I fall	Psychomotor functions (b147) Emotional function (b152) Thought functions (b160) High-level cognitive functions (b164)- specifically

		insight, judgment, and problem-solving (b1644, b1645, b1646) Experience of self and time functions (b180) Sensation of pain (b280) Family relationships (d760) Community life (d910) Individual attitudes (e410,415,420,425,430,440,445,450,455,460,465)-attitudes, unspecific (e499)
5	- I keep thinking about how much it might hurt if I fall	Psychomotor functions (b147) Emotional function (b152) Thought functions (b160) High-level cognitive functions (b164)- specifically insight, judgment, and problem-solving (b1644, b1645, b1646) Experience of self and time functions (b180)
	• b is body function • s is body structure	• d is activity and participation • e is for environmental factors

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Curriculum Vitae
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Education

University of Nevada, Las Vegas- Las Vegas, NV
Doctorate of Physical Therapy, May 2014
Portland State University – Portland, Oregon
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Significant Coursework

Anatomy and Physiology
Neuroanatomy and Physiology
Neurologic Rehabilitation
Biomechanics/Orthotics & Prosthetics
Exercise Physiology
Motor Learning and Behavior
Orthopedic Principles, Assessment and Rehabilitation
Cardiopulmonary Rehabilitation
Pediatric Rehabilitation
Research Methods and Research Statistics

Professional Experience

Children's Medical Center at Specialty Care Center - South Lake, TX
January 2014 – March 2014
Outpatient pediatric physical therapy, evaluated and treated children 0-19 years of age, attended and assisted with Neuromuscular Clinic, wheelchair clinic and inpatient physical therapy
St. Rose Dominican Hospital , Siena Campus - Las Vegas, NV
October 2013 – December 2013
Inpatient acute care physical therapy, evaluated and treated adults and children in the hospital, assisted with negative-pressure wound therapy application/removals, observed treatment in the NICU
Complex Care Hospital at Tenaya - Las Vegas, NV
July 2013 – September 2013
Long term acute care hospital rehabilitation therapy
Physiotherapy Associates – Puyallup, WA
June 2012 - August 2012
Orthopedic outpatient physical therapy

Research Experience

Doctoral Dissertation:
Beckett JL, Harmon AA, Hickman R, Landers MR. *Development of a tool to assess children's perceptions of their own balance (the pediatric balance perception battery): a pilot study.* January 2012-May 2014.

Professional Memberships and Related Workshops

American Physical Therapy Association Student Member since 2011: Pediatrics, Orthopedics, Aquatics, and Research Sections

Nevada Physical Therapy Association Student Member since 2011
Coordinator of the UNLV Physical Therapy Annual Golf Tournament- June 2013 Las Vegas, NV
Planned and organized tournament at Badlands Golf Course with a majority of proceeds benefitting KIDDOS, Kids in Dire, Difficult Orthopedic Situations, non-profit foundation
Golden Key International Honor Society : UNLV, member since December 2011
Combined Sections Meeting, Chicago, IL- February 2012
Nevada Physical Therapy Association CEU
Fall Risk Assessment & Fall Prevention for Older Nevadans by Jenifer Nash, PT, DPT- September 2012
Explain Pain by Adriaan Louw, PT Las Vegas, NV- May 2012 and 2013
Volunteer for Sanctity of Hope and Givetokens.org- Portland, OR since 2013

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Significant Coursework

Anatomy and Physiology
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Orthopedic Principles, Assessment and Rehabilitation
Cardiopulmonary Rehabilitation
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Research Methods and Research Statistics

Professional Experience and Teaching

Summerlin Hospital
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Corona Del Mar, CA
October 2013 to December 2013
Student Physical Therapist
Responsibilities:
Supervised clinical affiliation in an outpatient orthopedic setting

Scripps Memorial Hospital, Encinitas
Encinitas, CA
July 2013 to September 2013
Student Physical Therapist
Responsibilities:
Supervised clinical affiliation in an inpatient rehabilitation setting

Professional Physical Therapy and Sports Medicine
Orem, UT
June 2012 to August 2012

Student Physical Therapist
Responsibilities:
Supervised clinical affiliation in an outpatient orthopedic setting

University of Nevada, Las Vegas
Las Vegas, NV
August 2012 to May 2013
Graduate Assistant
Responsibilities:
Guided students in finding clinical affiliations
Tutored physical therapy students (Including anatomy, orthopedics, neuroanatomy and physiology)

Research Experience

Doctoral Dissertation

Beckett JL, Harmon AA, Hickman R, Landers MR. *Development of a tool to assess children's perceptions of their own balance (the pediatric balance perception battery): a pilot study.* January 2012 – May 2014.

Professional Membership and Related Workshops

American Physical Therapy Association (APTA), July 2011 to present
Pediatrics Section, APTA, May 2013 to present
American Academy of Pain Management Conference, Las Vegas, September 2011
Combined Sections Meeting, Chicago, IL February 2012
Combined Sections Meeting, Las Vegas, NV February 2014