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Predicting adherence to ankle-foot orthoses in people with stroke: An application of the Theory of Planned Behavior

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Abstract

Background: Ankle-foot orthoses (AFOs) are often prescribed for people with stroke to address motor impairment. However, not all patients adhere to using their AFOs as prescribed. Predictors of AFO adherence are likely to constitute useful targets for interventions that aim to promote this behavior.

Objective: To identify the predictors of AFO adherence in people with stroke using an established theoretical framework, namely the Theory of Planned Behavior (TPB; Ajzen, 1991).

Study design: Prospective survey design.

Method: N = 49 people who had been prescribed an AFO after a stroke completed a TPB questionnaire. One month later, they completed another questionnaire that measured adherence to AFOs as prescribed by an orthotic practitioner. Predictors of intention and AFO-adherence behavior were identified using regression analyses.

Results Adherence to AFOs was 63%. The TPB accounted for 61% of the variance in intentions and 43% of the variance in AFO-adherence behavior. Attitude and perceived behavioral control were predictors of intention, and intention was the sole predictor of behavior.

Conclusion The TPB is a useful model for explaining adherence to AFOs in people with stroke. Interventions could be designed to increase intentions to use an AFO as prescribed by promoting positive attitudes towards, and perceived behavioral control of AFO adherence.

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Introduction

Stroke is the leading cause of acquired adult disability worldwide.[1] The risk of stroke increases with advancing age, and, in the United Kingdom, with a growing elderly population, the number of stroke survivors is 1.3 million.[2] After a stroke, damage to the brain can cause a range of effects including difficulties in movement, visual disturbances, cognitive difficulties, depression, speech and language difficulties, bladder and bowel disturbance, and pain. The most common and widely recognized impairment caused by stroke is motor impairment,[3] with hemiplegia, a paralysis of one side of the body, or hemiparesis, a weakness of one side of the body, commonly seen.

A person with hemiplegia after stroke will typically walk with a "drop" foot, most easily identified during the swing phase of gait, and may have difficulty clearing the toes from the ground. However, the main biomechanical challenges are seen in stance phase, with initial contact often being made with the forefoot, causing extension at the knee throughout stance phase, and difficulty initiating knee flexion during swing phase. Ankle-foot orthoses (AFOs) are frequently used to maintain the foot in an optimally aligned position in stance phase, to allow clearance of the foot during swing phase, and to improve mobility and balance after stroke.[4,5] However, many people who have been prescribed orthotic devices do not adhere to using them.[6,7]

Adherence can be defined as the extent to which a person's health behavior corresponds with agreed recommendations from a health care provider.[8] Previous research that has investigated adherence to orthoses in neurological conditions has highlighted challenges in defining and measuring adherence.[9,10] Specifically, in people with stroke, there is limited knowledge about use of AFOs after they have been prescribed. Two previous studies that have investigated use of or adherence to AFOs after stroke highlighted challenges in adherence to AFOs, but also defined adherence in different ways. One investigation[11] did not provide an indication of the extent of use of the orthoses each day or if orthotic use matched recommendations for use. Another study[12] defined compliance as 3 h per day, 5 days per week. The term "compliance" does not recognize the role of the user in agreeing to recommendations for orthotic use. In this investigation, adherence to AFOs is defined as use of AFO as recommended by the

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orthotic practitioner. This implies that recommendations are agreed with the user and also personalized to the individual.

Nonadherence to AFOs may lead to reduced health outcomes for people who have been prescribed AFOs and is a significant concern for orthotic services because of an inefficient use of scarce resources when devices are not used. Although previous research has identified some potential reasons for nonadherence to AFOs, attempts at explaining adherence to orthoses have not used a theoretical perspective.[6,10,11] The lack of theory to understand adherence to orthoses has been unfortunate because opportunities to design theory-based interventions, which could potentially improve a person's physical and mental well-being, have not been exploited.

Theoretical approach

The use of psychological theories is important because they provide frameworks, which can be used to identify potentially modifiable variables that underpin health behaviors, such as adherence to AFOs. Interventions (e.g., educational materials) can be subsequently designed to target the variables that are known to underpin health behaviors. It is known such theoretically targeted interventions are more effective at changing behavior than interventions that are based primarily on intuition.[13] Therefore, in the present context, theoretical research to understand adherence to AFOs has the potential to inform interventions that optimize adherence and improve physical and mental health outcomes for orthotic users.[7]

The Theory of Planned Behavior (TPB)[14] is one of the most widely used psychological theories. It has been used to explain a wide range of social and health behaviors in different populations.[15,16] The TPB has generally been able to explain more variance in behavior than other theoretical models.[15] The TPB (Figure 1) states that the likelihood of a person engaging in a behavior is determined by their intentions (a person's willingness to perform a behavior) and perceived behavioral control (the perceived ease or difficulty of performing the behavior). Intentions are, in turn, influenced by attitudes (positive or negative evaluations about the performance of a behavior), subjective norms (perceived social pressure from significant others to adopt the behavior), and perceived behavioral control. Therefore, in applying the TPB to adherence to AFO use, a positive attitude toward adhering to AFO use, perceived support from significant others for using an AFO, and a perceived ease of using the AFO by the individual may lead to a positive intention to use an AFO and, in turn, positively impact on adherence to the AFO.

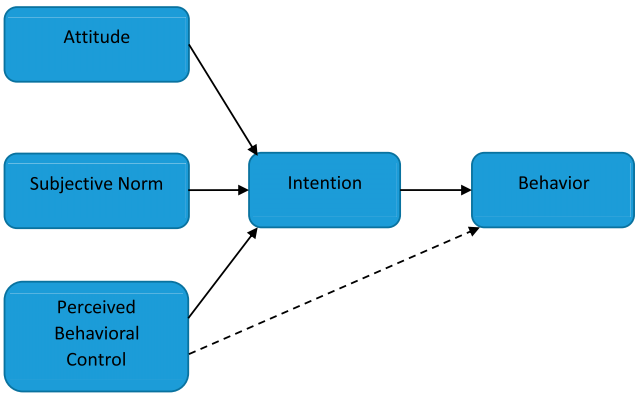

Figure 1. The Theory of Planned Behavior (Ajzen, 1991).

The TPB has been shown to account for large proportions of variance (i.e., in excess of $R^2 = 0.25$) in many health behaviors in the general population such as exercise[17] and smoking.[18] In addition, it has been shown to account for variance in adherence to exercise,[19] medication,[20] and self-care behaviors[21] by people with a range of different health conditions. However, the TPB has not previously been applied to orthotic use. Given that stroke is the leading cause of acquired adult disability and is one of the most common reasons for orthotic intervention, the aims of this investigation were to evaluate the TPB as a predictive model for explaining adherence to AFOs in people with stroke. It was hypothesized that attitude, subjective norms, and perceived behavioral control would account for a significant proportion of the variance in intentions to adhere to AFOs and intentions, and perceived behavioral control would account for a significant proportion of the variance in AFO-adherence behavior.

Method

Participants

Participants were 49 people, who had been prescribed an AFO because of a stroke, between 2014 and 2017. The demographic and clinical characteristics of the sample are shown in Table 1.

Design and procedure

A prospective survey design was used. The TPB constructs (attitude, subjective norm, perceived behavioral control, and intention) were measured at time 1 (T1). Behavior (adherence to recommended AFO usage) was measured at time 2 (T2), 1 month later. This ensured there was a temporal space between the TPB constructs and behavior, reflecting the theorized causal path between intention and behavior.[16,22] A 1-month gap was considered to be a reasonable length of time to enable any new patients to build up tolerance to wearing an AFO. Forty-nine participants (31%) responded at T1, using a return-addressed, postage-paid envelope. Of the 49 T1 respondents, 42 (86%) responded at T2. The response rates were consistent with previous studies with patient groups using a postal survey methodology.[23,24]

Ethical approval was obtained from Newcastle and North Tyneside NRES Committee (REC reference: 14NE1002) (IRAS project ID: 146140) and was endorsed by the University of Strathclyde Ethics Committee.

Measures

Demographic and clinical measures

The questionnaire asked participants to detail their age, gender, and marital status. Information on length of time since stroke, perceived current health status, perceived seriousness of stroke, length of time since the AFO was prescribed, and use of the AFO was also requested.

TPB questionnaire

A TPB questionnaire (see Supplemental Digital Content 1, http://links.lww.com/POI/A245) was designed using relevant guidelines.[25,26] The

Table 1. Demographic and Clinical Characteristics of Sample (n = 49).

Characteristics	N (%)	Mean (SD)	Range
Age		62.8 y (13.9)	22–86 y
Gender			
Female	26 (53)		
Male	23 (47)		
Marital status			
Married	29 (61.7)		
Widowed	7 (14.9)		
Single	5 (10.6)		
Divorced	4 (8.5)		
Living with partner	2 (4.3)		
Length of time since stroke		51.2 mo (46.5)	1–230 mo
Perceived current health status		3.80 (0.79)	2–5
Perceived seriousness of stroke		5.14 (2.15)	1–7
Length of time since AFO prescribed		29.4 mo (32.1)	1–122 mo
AFO-adherence behavior (t2, n = 41)			
Use as recommended	26 (53.1)		
Did not use as recommended	15 (30.6)		
AFO use (no. of hours/wk.)		72.2 h (35.4)	0–168 h
AFO (which side?)			
Right	21 (45)		
Left	26 (55)		

Perceived current health status scored between 1 and 5: 1 = excellent; 2 = very good; 3 = good: 4 = fair; and 5 = poor. Perceived seriousness of stroke scored between 1 and 7: 1 = not serious at all; 2 = not serious; 3 = not too serious; 4 = fairly serious; 5 = quite serious; 6 = serious; and 7 = very serious.

questionnaire included items to measure attitude, subjective norm, perceived behavioral control, and intention. All items were measured on 7-point scales. The items were pseudorandomized to minimize consistency biases, and the response scales were reversed on some questions to prevent response set biases.[27] Attitude was measured using the mean of 5 items (Cronbach's alpha $\alpha = 0.91$). The items tapped both the instrumental (e.g., "For me, using my AFO in the next month would be…. *harmful [1]/beneficial [7]*") and affective (e.g., "… *pleasant [7]/unpleasant [1]*") components of this construct.[28] The mean of 4 items was used to assess subjective norm ($\alpha = 0.75$). These items tapped both injunctive norms (e.g., "Most people important to me would want me to use an AFO in the next month": *strongly agree [1]* to *strongly disagree [7]*) and descriptive norms (e.g., "Most people who have an AFO are likely to use it in the next month": *very likely [1]* to *very unlikely [7]*).[28] Perceived behavioral control was measured using the mean of 3 items ($\alpha = 0.81$), which tapped into self-efficacy, which is the most predictive component of this construct (e.g., "I am confident that I can use my AFO in the next month," with responses ranging from *true [1]* to *false [7]*).[29] Intention was measured with 5 items ($\alpha = 0.89$), which asked about the overall motivation to use an AFO (e.g., "I want to use my AFO over the next month": *strongly agree [1]* to *strongly disagree [7]*) and likelihood of using an AFO (e.g., "How likely is it that you will use your AFO in the next month?": *very likely [1]* to *very unlikely [7]*).

Adherence to recommended AFO usage (behavior) was measured using 2 items: "In the last month, did you use your AFO?" (*yes* or *no*), and "In the last month. how often did you use your AFO?" (response options: *more often than recommended*; *about as often as recommended*; *less often than recommended*; *do not know—I was not told how often to use the AFO*; and *do not*

Table 2. Pearson's Correlation Coefficients Between TPB Variables and AFO-Adherence Behavior (n = 49).

Variables	Mean	SD	1	2	3	4	5
1. AFO adherence (yes/no)[a]	0.63	0.49	1.00	0.58[b]	0.46[b]	0.25	0.36[c]
2. Intention	5.64	1.72		1.00	0.72[b]	0.50[b]	0.74[b]
3. Attitude	5.37	1.69			1.00	0.62[b]	0.81[b]
4. Subjective norm	5.75	1.31				1.00	0.73[b]
5. Perceived behavioral control	5.86	1.64					1.00

[a]For correlations with AFO-adherence behavior n = 41.
[b]Correlation is significant at 0.01 level.
[c]Correlation is significant at 0.05 level.

Table 3. Multiple Regression Analysis of Behavioral Intentions to Use AFOs as Recommended (n = 46).

Independent variables	Unstandardized B	Std. Error	Standardized beta	t	*p*	Variance inflation factor
Attitude	0.50	0.17	0.47	2.89	0.01[a]	2.97
Subjective norm	−0.15	0.18	−0.12	−0.84	0.41	2.14
Perceived behavioral control	0.48	0.20	0.45	2.45	0.02[a]	3.85

(Adjusted) $R^2 = 0.61$; $F = 24.07$; $p = 0.000$.
[a]$p < 0.05$.

know—I cannot remember). A dichotomous score of adherence to recommended AFO use was produced (0 = did not use as recommended; 1 = used as recommended).

Analyses

All questionnaire data were coded and entered into SPSS® Version 23. Pearson's correlation coefficients (r) for all TPB variables and AFO use were computed to explore the univariate relationships. To identify predictors of intention, a multiple linear regression was performed with intention as the dependent variable and attitude, subjective norm, and perceived behavioral control as the independent variables. The adjusted R^2 was used as an overall estimate of the model fit. The standardized beta weights were examined to determine the independent effects of attitude, subjective norm, and perceived behavioral control on intentions. A multiple logistic regression was conducted with AFO-adherence behavior as the dependent variable and intention and perceived behavioral control as the independent variables. Goodness of fit of the logistic regression model was assessed using the Hosmer-Lemeshow statistic and Nagelkerke's R^2. Odds ratios were used to determine the independent effects of intention and perceived behavioral control on AFO-adherence behavior. Alpha was set at $\alpha = 0.05$ for all statistical tests.

Results

Of the 42 participants who completed the study (i.e., both questionnaires), one did not report if they used the AFO or not and was subsequently excluded from the analysis. Of the 41 remaining participants, 26 (63%) reported using their AFOs as recommended, and 15 (37%) reported that they did not.

Table 2 presents the mean and standard deviation and Pearson's correlation coefficients. AFO-adherence behavior was significantly positively associated with intentions to adhere ($r = 0.58$, $p < 0.001$), perceived behavioral control ($r = 0.36$, $p = 0.02$), and attitude ($r = 0.46$, $p < 0.01$). However, it was not significantly associated with subjective norms. Intentions were significantly and positively associated with attitude ($r = 0.72$, $p < 0.01$), subjective norm ($r = 0.50$, $p < 0.001$), and perceived behavioral control ($r = 0.74$, $p < 0.001$).

Predicting adherence intentions

Table 3 presents the results from the multiple linear regression with intention as the dependent variable and attitude, subjective norm, and perceived behavioral control as the independent variables. The variance in intention accounted for by the model was 61%. Table 3 shows the standardized regression coefficients, indicating that both attitude and perceived behavioral control were significant independent predictors of intention. However, subjective norm was not a significant predictor of intention.

Predicting adherence behavior

Table 4 presents the results from the logistic regression analysis, with adherence to recommended AFO use as the dependent variable and intention and perceived behavioral control as the independent variables. The model significantly predicted 43% of the variance ($\chi^2 = 15.11$, df = 2, $p = 0.001$; Hosmer-Lemeshow goodness of fit: $\chi^2 = 1.35$, $p > 0.05$). The odds ratios demonstrated that intention was the sole predictor of AFO adherence, with a one-unit increase in intention being associated with a 3.07-factor increase in the odds of adhering to recommended AFO use.

Discussion

This study provided the first investigation of the utility of the TPB in predicting adherence to recommended AFO usage in people with stroke. The use of a psychological model of behavior was a novel approach to understanding adherence to orthoses.

Adherence to AFOs

Adherence to recommended AFO use, over a 1-month period, was 63%. This compares favorably with previous investigations into adherence.[6,12] However, the resultant nonadherence rate of 37% represents a sizable proportion of participants who are either not engaging or only partially engaging with orthotic management after a stroke. Nonadherence to AFOs is associated with poorer outcomes in physical and mental health.[7] Therefore, this significant minority of people not adhering to AFOs is an important concern, which highlights the need to understand the factors affecting adherence to use of AFOs.

Table 4. Logistic Regression Analysis of AFO use as recommended (n = 40).

Variables	B	SE	Wald test	*p*	Odds ratio	CI (lower)	CI (upper)	Variance inflation factor
Intention	1.11	.48	5.42	0.02[a]	3.07	1.19	7.88	2.22
Perceived behavioral control	−0.33	0.44	0.57	0.45	0.72	0.31	1.70	2.22

CI, confidence interval.
Nagelkerke's R square = 0.43.
[a]$p < 0.05$.

The utility of the TPB in predicting adherence to AFOs

The TPB accounted for 61% variance in intentions and 43% variance in adherence to AFOs, which are both considered large effect sizes in the social sciences.[30] These observed variances are somewhat higher than in previous meta-analyses of the TPB. For example, Rich et al[31] investigated the utility of the TPB in predicting adherence behaviors in chronic conditions and reported 32% variance in intentions and 9% variance in behavior. The present findings, therefore, suggest that the TPB is particularly effective at predicting orthotic adherence for the stroke population.

The current study found that attitude and perceived behavioral control were significant predictors of intention to adhere to AFOs. In turn, intention was a significant predictor of adherence. Meta-analyses of the TPB investigating a range of behaviors[15,16] have reported similar findings, with attitude and perceived behavioral control being the most important predictors of intention and intention being the most important predictor of behavior. The findings suggest that promoting intentions to adhere to prescribed AFO use would be a useful intervention strategy for increasing AFO-adherence behavior. Fostering and supporting a positive attitude toward AFO adherence or increasing a person's sense of control over using the AFO are likely to be the most useful objectives for future interventions to promote the necessary intentions.

Subjective norm did not predict intention, and given that subjective norm is usually regarded as a weaker predictor of intention, compared with attitude and perceived behavioral control,[15,22] this finding is not entirely surprising. There were no obvious limitations to the measurement of subjective norms in the current investigation. Therefore, this may indicate that approval from others has little influence on intention to adhere to AFOs in people with stroke. This could be because the user interacts with the AFO in an intimate and personal way, so that adherence to AFOs is more likely to be influenced by personal beliefs (e.g., attitudes) rather than the beliefs about how significant others would view AFO adherence.

Such interventions that target attitudes and perceived behavioral control might include educational materials given to orthotic users when AFOs are provided (e.g., information leaflets and videos) or use of goal-setting or motivational-interviewing techniques[13] for patients who have been provided with AFOs. Consideration should also be given to ensuring the initial orthotic intervention is a positive experience (e.g., the AFO fits and functions well; is matched to the footwear; clear instructions are provided on use; and the AFO is provided in a timely fashion) because it is recognized that it is more challenging to change attitudes that are based on a negative experience, than those that are based on information alone.[32] Further investigation is required to identify the specific reasons why people might hold specific attitudes and perceived control about using AFOs. Considering TPB investigations in other domains,[33] research might usefully identify the specific beliefs that underpin people attitudes and perceptions of control to help shed light on these reasons. Again, following research in other domains,[34] these reasons, once known, can provide a basis for developing persuasive messages for promoting positive attitudes and perceptions of control in relation to AFO use.

Limitations

Some important limitations should be considered when interpreting the results. It is acknowledged that the number of participants who completed both time points in this study was small (n = 41). However, the findings are comparable with other meta-analyses of the TPB investigating a range of health behaviors, meaning that these findings are held with confidence. Future studies, which investigate orthotic adherence, should consider pooling participants across different health boards, to increase sample size. Secondly, a self-report measure was used to quantify the behavior under investigation. Self-report measures have been criticized, with an objective measure of adherence being considered as more accurate.[8] That said, self-report measures are frequently used in the social sciences and are often shown to be good proxies for objectively measured behavior.[35] An objective measure of adherence was not deemed feasible in this study because it would have required a new AFO to be manufactured for each participant, to enable usage to be accurately recorded (e.g., using an AFO with an activity or pressure monitor). As costs of health technologies become more affordable, it may become practical to incorporate such monitors routinely into orthotic design to enable digital monitoring of use. A further limitation is other potential factors that might affect intentions to use an AFO other than those contained within the TPB were not included in the analysis. These include factors such as socioeconomic, condition-related, treatment-related, patient-related, and healthcare system–related factors.[8] Although this study provided an independent test of the TPB, future research might include these other constructs, in addition to those proposed by the TPB, to potentially provide a more comprehensive understanding of the predictors of AFO use. The investigators did not assess the fit and function of the AFOs, and it is known that the quality of AFO fit and function can influence people's perceptions (e.g., attitudes) and their AFO use.[10] That said, all the participants in this investigation were fitted with their AFOs by Health and Care Professions Council–registered orthotists. Therefore, it is reasonable to assume that fit and function of the AFOs in this study were appropriate, and proper and consistent advice regarding orthotic use was provided. Finally, this investigation was performed in one geographical area, and orthoses were provided by a single health board in Scotland. Therefore, the applicability of these results to other populations in the United Kingdom should be investigated in future research.

Conclusion

In conclusion, this investigation provides support for use of the TPB as a theoretical framework for predicting AFO adherence after a stroke. Interventions (e.g., educational materials) are needed to foster and support positive attitudes toward the use of AFOs as recommended by orthotic practitioners and potentially to increase perceived behavioral control. Research identifying specific beliefs that underpin attitudes and PBC would help to develop these interventions with a view to increasing AFO adherence and associated benefits (e.g., increased activity and participation after a stroke).

Previous presentation of this work

"Use of the Theory of Planned Behaviour to Predict Adherence to Ankle-foot Orthoses (AFOs) in People with Stroke Free Paper

Presentation" Free paper ISPO 17th World Congress Japan October 2019. "Use of the Theory of Planned Behaviour to Predict Adherence to Ankle-foot Orthoses (AFOs) in People with Stroke" Free Paper Presentation Scottish Stroke Allied Health Professions Forum Conference, Dundee, UK. "Use of the Theory of Planned Behaviour to Predict Adherence to Ankle-foot Orthoses (AFOs) in People with Stroke" Free paper British Association of Prosthetists and Orthotists Annual Conference (Online) October 2021. "Use of the Theory of Planned Behaviour to Predict Adherence to Ankle-foot Orthoses (AFOs) in People with Stroke" Free paper Australian Orthotics and Prosthetics Association (Online) Annual Conference October 2021. "Can Psychology Aid Our Understanding of Orthotic Adherence?" AOPA Newsletter Extended Abstract December 2021.

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