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International Journal of Nursing Sciences

journal homepage: <http://www.elsevier.com/journals/international-journal-of-nursing-sciences/2352-0132>

Original Article

Psychometric properties and characteristics of the Diabetes Self Management Scale

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ARTICLE INFO

Article history:

Received 14 December 2016

Accepted 10 April 2017

Available online 22 April 2017

Keywords:

Diabetes mellitus

Diabetes Self Management Scale

Psychometrics

Self care

ABSTRACT

Objective: Assessing diabetes self care management is essential for nursing care for diabetes. There is a need to have valid and reliable scales that assess the actual performance of diabetes self management. The purpose of this study was to revise and conduct psychometric testing and analysis of the Diabetes Self Management Scale (DSMS).

Methods: A cross-sectional methodological design was used. A convenience sample was used and 78 adults with diabetes and taking insulin from five sites in the Midwest area of the U.S participated in the study. Reliability analysis was done using Ferketich techniques to make decisions about whether any given item should be retained or deleted.

Results: A descriptive analysis for the 60 items of the scale was conducted; several items had low variability compared to the other items on the scale. The correlation matrices showed that a total of 20 items had poor item characteristics. These 20 items were deleted resulting in developing 40- item version of the scale. The 40 - item scale had high level of internal consistency (Cronbach's $\alpha = 0.947$). The validity testing of the 40 - item scale was guided by the Research Model for Diabetes Self Care Management; results were congruent with the model and showed strong correlation with self efficacy, moderate correlation with self care agency, and weak correlation with diabetes knowledge.

Conclusion: The items and the scale (DSMS) have undergone careful psychometric testing. The 40-item DSMS is a reliable and valid instrument to measure diabetes self care management among people with diabetes.

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1. Introduction

Diabetes is a chronic condition that affects a very large population in the United States and the whole world. Not only prevalent but also each year there is an increment in the morbidity rate [1]. So, diabetes self care management is considered essential in managing diabetes to help people with diabetes achieve glycemic control and prevent complications [2].

Diabetes Self care Management (DSCM) was defined as exercising of the actual performance of self care activities by those who

have diabetes to manage their condition. The goal of diabetes self care management is to maintain near-normal glucose levels by means of self care actions by following diet, performing physical activities, monitoring blood glucose level, using of medications, and other self care actions [3,4].

Reliable and valid instruments are important for the advancement of research and translation of research findings into practice [5]. Also, developing valid and reliable instruments to assess the actual performance of diabetes self management activities is important for providing appropriate interventions that can be effective in achieving the goals of diabetes management [6,7]. So, a scale to measure diabetes self care management was developed [6], this scale is the Diabetes Self Management Scale (DSMS). However, factor validity of the scale was not conducted. So, the authors recommended conducting further psychometric analysis and

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Peer review under responsibility of Chinese Nursing Association.

evaluation of its reliability, and further testing and revisions for the DSMS. Therefore, the aim of the study was to examine the reliability and item characteristics of the Diabetes Self Management Scale (DSMS) using the Research Model for Diabetes Self Care Management as theoretical framework to guide the analysis.

1.1. Background and conceptual framework for hypotheses testing

The research model for Diabetes Self Care Management was developed [3] through synthesizing knowledge about self care and identified a framework and described the relationships between diabetes self care management, self efficacy, self care agency, and diabetes knowledge (See Fig. 1). This model proposed that direct relationships exist between self efficacy and self care management; and self care agency and self care management. The model also proposed indirect relationship between diabetes knowledge and DSCM.

1.2. The Diabetes Self Management Scale (60- item DSMS)

In Sousa et al.'s [6] study to develop new measures of DSCM and other concepts, the authors indicated that various tools to measure DSCM are available in the literature but all have limitations such as low reliability, lack of content and construct validity. So, Sousa and colleagues developed the DSMS using American Diabetes Association (ADA) and American Association of Diabetes Educators (AADE) current standards of care, empirical works, and Orem's self care theory. The scale included aspects of healthy eating, being active, monitoring blood glucose, taking medication, problem solving, and reducing risks.

The DSMS scale is a 60 item scale with Likert-type response options that ranged from 0 (strongly disagree) to 5 (strongly agree). The DSMS total score can range from 0 to 300 with higher score indicating higher level of self care. The reliability and validity of the scale was assessed [6] using a sample of the 10 clinicians and 10 insulin-treated persons with type 2 diabetes (T2DM). Thirteen items of the DSMS had interrater reliability less than the recommended level of 80%. The expert panel also reported that two of the DSMS items had low level of consistency with the current standards of diabetes care. However, item analysis, reliability analysis, and the factor validity of the scale and the scale dimensions were not tested. Further psychometric testing is needed [6]. Therefore, the aim of this study was to evaluate the item characteristics and reliability of the Diabetes Self Management Scale (DSMS). Permission to use and edit the DSMS scale was obtained from the original author [6] prior to conducting this study.

2. Methods

2.1. Design

A cross-sectional methodological design was used to conduct

the study. Methodological design is preferred in developing, validating, evaluating and refining research instruments. Scale and item analysis were used to evaluate and refine the scale.

2.2. Sample

The sample size was determined based on recommendations of [8]. Based on their rules to calculate the minimum sample size for a correlational study, a minimum sample size of (75) participants were needed for this study.

A convenience sample of 78 participants with complete data was recruited for the study. The inclusion criteria for the sample were:

- 1) 18 years or older,
- 2) Medical diagnosis of either T1DM or T2DM,
- 3) Minimum diabetes duration of 6 months,
- 4) Taking insulin, and
- 5) Ability to understand, speak, and write in English.

The reason for limiting the sample to those taking insulin was to obtain participants who required more complex capabilities to perform specific self care activities to appropriately manage diabetes. Individuals who were pregnant, not managed by insulin, or had cognitive impairments were excluded from the study. The sample was collected from 5 sites located in a Midwest metropolitan area.

2.3. Ethical considerations

Human Subject Committee approval was obtained from the University of Kansas Medical Center (KUMC) Institutional Review Board prior to data collection. Five sites in the Midwest area of the U.S agreed to participate in the study. A staff member at each site agreed to screen their patients or clients for study inclusion criteria listed in the sample section above. All had completed the KUMC human subjects tutorials and were trained in screening for study criteria.

2.4. Data collection and research procedure

Patients and clients who fit the criteria were informed about the study and invited to participate in the study. If they agreed to participate, they were given a questionnaire packet. The packet included the 60 –item Diabetes Self Management Scale (DSMS), the Diabetes Self Efficacy Scale (DSES), the Diabetes Knowledge Test (DKT), and The Appraisal of Self care Agency Scale Revised (ASAS-R). A cover letter containing a summary of the study, the participant's rights, and the researcher's contact information was included with the questionnaire packet. The cover letter also encouraged the potential participants to complete the questionnaire and return it as soon as possible to the investigator. No

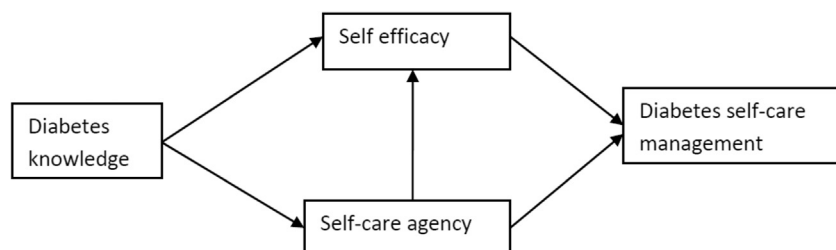


Fig. 1. The relationships between the concepts of the Research Model for Diabetes Self care Management as proposed by Sousa et al. (2004).

identifiable information was collected. Data were cleaned, coded and prepared for data analysis by the researcher.

2.5. Data analysis

For the research aim, the items of the DSMS were assessed using Ferketich [9] techniques that help in making a decision about whether any given item should be retained or deleted. These techniques included assessing the average correlations of the items, inter-item correlation matrix, corrected item-total correlation, alpha if item deleted, item validity estimate, and item variability.

The average correlation of the item with the other items on the scale and the correlation define if the item is unnecessary or not related to the scale. The rule of thumb is that items that correlate below (0.3) are not sufficiently related to the measure and items that correlate over (0.7) are redundant. Item total correlation describes if the item is a large part of the total. In other words, the stronger the item-total correlation, the better the item is. In general, item total correlation above (0.3) is considered good. Item validity was assessed by correlating the item with an outside criterion. In this study the items were correlated with self efficacy because self efficacy was found to have strong correlation with DSCM. Item variability was assessed by measuring the SD for the item. A second reliability analysis was done after deleting the identified 'problem' items in the scale.

3. Results

3.1. Sample characteristics

A total of 78 participants returned complete questionnaires. The typical study participant was a 47 year-old Caucasian (52.6%) male (56.4%), who was married (47.4%) and had at least a high school education (88.5%). No Latino, Native Hawaiian or Pacific Islander participated in the study. Just over half of participants were persons with T2DM (55.1%, $n = 43$) and 44.9% were persons with T1DM ($n = 35$). The mean years of having diabetes was 11.9 ($SD = 10.3$) and ranged from 1 to 41 years. High cholesterol level ($n = 34$) and high blood pressure ($n = 30$) were the 2 most reported complications by participants. Half of participants (50%, $n = 39$) reported taking insulin injections only and the other half (50%, $n = 39$) reported taking insulin injections and pills. Most participants reported they either did not smoke (61%, $n = 48$) or did not drink

(76%, $n = 60$). Those who both did not smoke and drink composed about 52% ($n = 42$) of participants.

3.2. Psychometric characteristics of the 60 item DSMS scale

Diabetes Self Care Management (DSCM) was operationalized using the Diabetes Self Management Scale (DSMS). A review of the content and wording of the items was done to assess for presence of statements that may create confusion in understanding the item. The initial review showed that there are absolute phrases in some items – such as “all the time” and “every day” – that may have contributed to confusion between the wording of the item and the available response options (Strongly Disagree to Strongly Agree). These items were earmarked to monitor in remaining item analyses. Then, a descriptive analysis for all the 60 items of the scale was conducted to assess the responses of the participants on these items in terms of central tendency and dispersion. Several items had low variability ($SD < 1.2$) compared to the other items on the scale; and some items had a median of the highest possible score on the items (See Table 1 for the items with relatively low variability).

3.3. Development of the 40 item DSMS

Ferketich [9] identified techniques to help in making a decision about whether any given item should be retained or deleted. These techniques included assessing the average correlations of the items, inter-item correlation matrix, corrected item-total correlation, alpha if item deleted, item validity estimate, and item variability. The average correlation of the item with the other items on the scale and the correlation define if the item is unnecessary or not related to the scale. Item total correlation describes if the item is a large part of the total. In general, item total correlation above 0.3 is considered good.

The revised alpha if item deleted identifies if deleting the item will improve, fail to improve, or worsen the internal consistency estimate of the scale. The item validity estimate can be obtained by correlating the individual items with an outside criterion. In this study the outside criterion was self efficacy because self efficacy was found to be strongly associated with diabetes self care management ($r = 0.801$). (See Table 2 for the characteristics of DSMS items).

A correlation matrix with the average correlation for the 60 items of the DSMS was made to assess the characteristics of the

Table 1
Item characteristics for DSMS: Items with low variability.

| Item number and content | Possible range (Midpoint) | Mean | SD | Median | Corrected item-total correlation | Cronbach's α if item deleted |
|-------------------------|---------------------------|------|------|--------|----------------------------------|-------------------------------------|
| 3 ^a | 0–5(2.5) | 2.64 | 1.17 | 3 | 0.644 | 0.957 |
| 9 ^a | 0–5(2.5) | 2.77 | 1.18 | 3 | 0.594 | 0.957 |
| 10 ^a | 0–5(2.5) | 2.65 | 1.17 | 3 | 0.501 | 0.957 |
| 29 | 0–5(2.5) | 4.05 | 1.28 | 4 | 0.477 | 0.958 |
| 33 | 0–5(2.5) | 4.12 | 1.17 | 5 | 0.450 | 0.958 |
| 34 | 0–5(2.5) | 4.14 | 1.15 | 5 | 0.308 | 0.958 |
| 37 | 0–5(2.5) | 4.00 | 1.12 | 4 | 0.360 | 0.958 |
| 39 ^a | 0–5(2.5) | 4.03 | 1.18 | 4 | 0.195 | 0.958 |
| 43 | 0–5(2.5) | 3.97 | 1.06 | 4 | 0.504 | 0.957 |
| 44 | 0–5(2.5) | 4.45 | 0.75 | 5 | 0.375 | 0.958 |
| 45 | 0–5(2.5) | 4.42 | 0.99 | 5 | 0.279 | 0.958 |
| 46 | 0–5(2.5) | 3.65 | 1.14 | 4 | 0.578 | 0.957 |
| 51 | 0–5(2.5) | 3.99 | 1.01 | 4 | 0.592 | 0.957 |
| 52 | 0–5(2.5) | 3.64 | 1.04 | 4 | 0.666 | 0.957 |

^a Item with absolute phrases – such as “all the time” and “every day”.

Table 2
DSMS items characteristics.

| Item | Average correlation | Item total correlation | Cronbach's α if deleted | Correlation with SE | SD | Number of correlations <0.3 | Number of correlations >0.7 |
|-----------------|---------------------|------------------------|--------------------------------|---------------------|-------|-----------------------------|-----------------------------|
| 1 ^a | 0.369 | 0.671 | 0.957 | 0.544 | 1.461 | 23 | 2 |
| 2 ^a | 0.160 | 0.270 | 0.958 | 0.368 | 1.439 | 50 | 0 |
| 3 ^a | 0.353 | 0.644 | 0.957 | 0.510 | 1.170 | 27 | 2 |
| 4 | 0.373 | 0.678 | 0.957 | 0.550 | 1.276 | 22 | 4 |
| 5 | 0.335 | 0.597 | 0.957 | 0.454 | 1.243 | 33 | 0 |
| 6 | 0.336 | 0.607 | 0.957 | 0.454 | 1.429 | 23 | 1 |
| 7 ^a | 0.232 | 0.421 | 0.958 | 0.319 | 1.474 | 40 | 0 |
| 8 ^a | 0.377 | 0.694 | 0.957 | 0.529 | 1.474 | 16 | 1 |
| 9 ^a | 0.330 | 0.594 | 0.957 | 0.404 | 1.183 | 27 | 0 |
| 10 ^a | 0.278 | 0.501 | 0.957 | 0.373 | 1.171 | 33 | 0 |
| 11 | 0.336 | 0.609 | 0.957 | 0.497 | 1.325 | 26 | 0 |
| 12 | 0.373 | 0.673 | 0.957 | 0.448 | 1.418 | 21 | 0 |
| 13 | 0.228 | 0.394 | 0.958 | 0.391 | 1.387 | 44 | 0 |
| 14 ^a | 0.357 | 0.638 | 0.957 | 0.483 | 1.704 | 23 | 0 |
| 15 ^a | 0.375 | 0.676 | 0.957 | 0.477 | 1.515 | 18 | 0 |
| 16 | 0.283 | 0.517 | 0.957 | 0.493 | 1.623 | 35 | 1 |
| 17 | 0.307 | 0.564 | 0.957 | 0.551 | 1.654 | 34 | 3 |
| 18 | 0.380 | 0.704 | 0.957 | 0.611 | 1.562 | 19 | 2 |
| 19 | 0.312 | 0.579 | 0.957 | 0.537 | 1.493 | 28 | 2 |
| 20 | 0.419 | 0.770 | 0.956 | 0.565 | 1.356 | 15 | 1 |
| 21 | 0.359 | 0.653 | 0.957 | 0.576 | 1.434 | 22 | 1 |
| 22 | 0.296 | 0.524 | 0.957 | 0.370 | 1.518 | 37 | 0 |
| 23 | 0.316 | 0.557 | 0.957 | 0.472 | 1.488 | 26 | 0 |
| 24 | 0.244 | 0.426 | 0.958 | 0.400 | 1.413 | 37 | 0 |
| 25 | 0.249 | 0.439 | 0.958 | 0.339 | 1.518 | 39 | 0 |
| 26 ^a | 0.399 | 0.740 | 0.956 | 0.595 | 1.616 | 19 | 0 |
| 27 | 0.279 | 0.484 | 0.958 | 0.462 | 1.439 | 38 | 1 |
| 28 | 0.370 | 0.660 | 0.957 | 0.621 | 1.312 | 19 | 0 |
| 29 | 0.281 | 0.477 | 0.958 | 0.312 | 1.288 | 37 | 2 |
| 30 | 0.309 | 0.536 | 0.957 | 0.401 | 1.448 | 30 | 2 |
| 31 | 0.241 | 0.406 | 0.958 | 0.208 | 1.609 | 43 | 1 |
| 32 | 0.320 | 0.561 | 0.957 | 0.370 | 1.555 | 27 | 1 |
| 33 | 0.266 | 0.450 | 0.958 | 0.365 | 1.173 | 40 | 2 |
| 34 | 0.190 | 0.308 | 0.958 | 0.256 | 1.148 | 45 | 0 |
| 35 ^a | 0.215 | 0.384 | 0.958 | 0.352 | 1.630 | 47 | 0 |
| 36 | 0.276 | 0.490 | 0.957 | 0.486 | 1.351 | 34 | 1 |
| 37 | 0.211 | 0.360 | 0.958 | 0.411 | 1.117 | 47 | 1 |
| 38 ^a | 0.206 | 0.348 | 0.958 | 0.160 | 1.448 | 48 | 0 |
| 39 ^a | 0.130 | 0.195 | 0.958 | 0.177 | 1.184 | 55 | 0 |
| 40 ^a | 0.249 | 0.425 | 0.958 | 0.353 | 1.352 | 38 | 0 |
| 41 | 0.290 | 0.519 | 0.957 | 0.434 | 1.688 | 30 | 0 |
| 42 | 0.305 | 0.534 | 0.957 | 0.483 | 1.121 | 31 | 0 |
| 43 | 0.294 | 0.504 | 0.957 | 0.460 | 1.057 | 28 | 1 |
| 44 | 0.227 | 0.375 | 0.958 | 0.302 | 0.750 | 41 | 0 |
| 45 | 0.176 | 0.279 | 0.958 | 0.249 | 0.989 | 45 | 0 |
| 46 | 0.333 | 0.578 | 0.957 | 0.492 | 1.138 | 26 | 1 |
| 47 ^a | 0.237 | 0.422 | 0.958 | 0.215 | 1.493 | 38 | 0 |
| 48 ^a | 0.250 | 0.446 | 0.958 | 0.269 | 1.928 | 38 | 0 |
| 49 | 0.281 | 0.491 | 0.957 | 0.473 | 1.271 | 36 | 1 |
| 50 | 0.194 | 0.333 | 0.958 | 0.312 | 1.678 | 42 | 0 |
| 51 | 0.335 | 0.592 | 0.957 | 0.569 | 1.013 | 29 | 0 |
| 52 | 0.374 | 0.666 | 0.957 | 0.587 | 1.043 | 21 | 2 |
| 53 | 0.403 | 0.725 | 0.957 | 0.643 | 1.305 | 17 | 2 |
| 54 ^a | 0.375 | 0.674 | 0.957 | 0.579 | 1.385 | 21 | 2 |
| 55 | 0.278 | 0.484 | 0.957 | 0.446 | 1.304 | 40 | 0 |
| 56 | 0.178 | 0.302 | 0.958 | 0.346 | 1.663 | 52 | 0 |
| 57 | 0.295 | 0.529 | 0.957 | 0.493 | 1.633 | 27 | 0 |
| 58 | 0.265 | 0.466 | 0.958 | 0.531 | 1.469 | 39 | 0 |
| 59 | 0.320 | 0.563 | 0.957 | 0.540 | 1.402 | 26 | 0 |
| 60 | 0.267 | 0.471 | 0.958 | 0.395 | 1.739 | 32 | 0 |

^a Item with absolute phrase like "all the time" or "everyday".

items. The correlation matrix showed that 25 items had correlations over 0.7 with other items on the scale. Such high correlations indicate redundancy [9]. The items that had strong correlations with each other were aggregated into groups (See Table 3). These items in the groups were then evaluated for their characteristics

and compared with each other. The items with the less desirable characteristics or less desirable wording were deleted (See Table 4 for the items that were deleted and the rationales for deleting them).

Out of the 60 items that compose the original scale, 20 items

Table 3
The Aggregations of the items with strong correlations (>0.70).

| Item number | Number of Strong Correlation | Correlates Strongly with items number |
|-------------|------------------------------|---------------------------------------|
| 1 | 2 | 3, 4 |
| 3 | 2 | 1, 4 |
| 4 | 4 | 1, 3, 6, 8 |
| 6 | 1 | 4 |
| 8 | 1 | 4 |
| 16 | 1 | 17 |
| 17 | 3 | 16, 18, 19 |
| 18 | 2 | 17, 19 |
| 19 | 2 | 17, 18 |
| 20 | 1 | 21 |
| 21 | 1 | 20 |
| 27 | 1 | 49 |
| 29 | 2 | 30, 33 |
| 30 | 2 | 29, 33 |
| 31 | 1 | 32 |
| 32 | 1 | 31 |
| 33 | 2 | 29, 30 |
| 36 | 1 | 37 |
| 37 | 1 | 36 |
| 43 | 1 | 46 |
| 46 | 1 | 43 |
| 49 | 1 | 27 |
| 52 | 2 | 53, 54 |
| 53 | 2 | 52, 54 |
| 54 | 2 | 52, 53 |

Table 4
The deleted DSMS items and the rationale.

| Item | Decision | Rationale |
|------|----------|---|
| 1 | Keep | Seems redundant (2 correlations >0.7). Redundant of items 3 and 4, best among items 1, 3, and 4. |
| 2 | Delete | Low average correlation and low item-total correlation. Low correlation with most the other items on the scale. |
| 3 | Delete | Seems redundant (2 correlations >0.7). Redundant of items 1 and 4, but has less desirable item characteristics. |
| 4 | Delete | Seems redundant (High correlation with 4 other items). Had the highest number of correlations over 0.7). Redundant of items 1, 3, 6, 8. |
| 7 | Delete | Low average correlation. Low correlation with many the other items on the scale. Contains absolute phrase |
| 10 | Delete | Low average correlation. Low correlation with over half the items on the scale. Low variability. Contains absolute phrase |
| 17 | Delete | Seems redundant (3 correlations >0.7). Redundant of items 16, 18, 19. Less desirable item characteristics than item 18. Low correlation with many items. |
| 18 | Keep | Seems redundant (2 correlations >0.7). Best among 17, 18, 19. Better item total correlation. Better item validity. |
| 19 | Delete | Seems redundant (2 correlations >0.7). Less desirable characteristics than item 18 from the group. Lower item validity. Lower item total correlation. |
| 29 | Delete | Seems redundant (2 correlations >0.7). Redundant of items 30, 33. Less desirable characteristics than item 30. Low average correlation. Lower item total correlation. |
| 30 | Keep | Seems redundant (2 correlations >0.7). Best among items 29 and 30. Better average correlation. Stronger item total correlation. Better item validity. |
| 31 | Delete | Low average correlation. Low item validity. Low correlation with many other items on the scale. Less desirable characteristics than item 32. |
| 32 | Keep | Better item characteristics than item 31. Good average correlation. Better item total correlation. Better item validity. |
| 33 | Delete | Low variance. Low average correlation. Low correlation with many other items on the scale. Low variance. Seems redundant (2 correlations >0.7) of items 29, 30. |
| 34 | Delete | Low average correlation. Low item validity. Low correlation with many the other items on the scale. Low variability. |
| 35 | Delete | Low average correlation. Low correlation with many the other items on the scale. Contains absolute phrase. |
| 37 | Delete | Low item variability. Low average correlation. Low correlation with many the other items on the scale. |
| 38 | Delete | Low average correlation. Low correlation with many the other items on the scale. Contains absolute phrase. Low item validity. |
| 39 | Delete | Low average correlation. Low correlation with most the other items on the scale. Contains absolute phrase. Low item validity. Low item total correlation. |
| 44 | Delete | Low average correlation. Low correlation with most the other items on the scale. Low variance. |
| 45 | Delete | Low average correlation. Low correlation with many other items on the scale. Low variance. Low validity. |
| 47 | Delete | Low item validity. Low average correlation. Alpha if deleted fails to improve. Contains absolute phrase. |
| 52 | Delete | Seems redundant (2 correlations >0.7). Redundant of 53, 54. Less desirable characteristics than item 53. |
| 53 | Keep | Seems redundant (2 correlations >0.7). Best of 52 and 53. |
| 54 | Delete | Seems redundant (2 correlations >0.7). Contains absolute phrase. |

Table 5
Descriptive statistics and reliability estimates for the main study variables ($n = 78$).

| Scale | Possible Range | Actual Range | Mean | SD | Cronbach's α |
|----------------------|----------------|---------------|-------|------|---------------------|
| SE | 0–300 | 131.00–293.00 | 214.8 | 38.4 | 0.949 |
| DSCM (40 item-scale) | 0–200 | 53.00–192.00 | 129.9 | 33.2 | 0.947 |

Note: SE= Self Efficacy, DSCM = Diabetes Self Care Management.

Table 6
Item characteristics for the 40-item DSMS.

| Item | Possible Range | Mean | SD | Corrected Item-Total Correlation | Cronbach's α if Item Deleted |
|------|----------------|------|------|----------------------------------|-------------------------------------|
| 1 | 0–5 | 2.76 | 1.46 | 0.674 | 0.945 |
| 5 | 0–5 | 2.96 | 1.24 | 0.611 | 0.946 |
| 6 | 0–5 | 2.54 | 1.43 | 0.623 | 0.946 |
| 8 | 0–5 | 2.55 | 1.47 | 0.726 | 0.945 |
| 9 | 0–5 | 2.77 | 1.18 | 0.590 | 0.946 |
| 11 | 0–5 | 2.90 | 1.32 | 0.621 | 0.946 |
| 12 | 0–5 | 3.04 | 1.41 | 0.649 | 0.945 |
| 13 | 0–5 | 3.71 | 1.38 | 0.370 | 0.947 |
| 14 | 0–5 | 3.08 | 1.70 | 0.643 | 0.945 |
| 15 | 0–5 | 2.87 | 1.51 | 0.679 | 0.945 |
| 16 | 0–5 | 2.74 | 1.62 | 0.501 | 0.946 |
| 18 | 0–5 | 2.12 | 1.56 | 0.675 | 0.945 |
| 20 | 0–5 | 2.49 | 1.35 | 0.760 | 0.945 |
| 21 | 0–5 | 2.91 | 1.43 | 0.639 | 0.945 |
| 22 | 0–5 | 3.08 | 1.51 | 0.513 | 0.946 |
| 23 | 0–5 | 3.38 | 1.48 | 0.583 | 0.946 |
| 24 | 0–5 | 3.65 | 1.41 | 0.445 | 0.947 |
| 25 | 0–5 | 3.27 | 1.51 | 0.438 | 0.947 |
| 26 | 0–5 | 2.56 | 1.61 | 0.733 | 0.945 |
| 27 | 0–5 | 3.73 | 1.43 | 0.483 | 0.947 |
| 28 | 0–5 | 3.62 | 1.31 | 0.655 | 0.945 |
| 30 | 0–5 | 3.86 | 1.44 | 0.523 | 0.946 |
| 32 | 0–5 | 3.15 | 1.55 | 0.526 | 0.946 |
| 36 | 0–5 | 3.69 | 1.35 | 0.481 | 0.947 |
| 40 | 0–5 | 3.87 | 1.35 | 0.373 | 0.947 |
| 41 | 0–5 | 3.22 | 1.68 | 0.518 | 0.946 |
| 42 | 0–5 | 3.94 | 1.12 | 0.532 | 0.946 |
| 43 | 0–5 | 3.97 | 1.05 | 0.504 | 0.946 |
| 46 | 0–5 | 3.65 | 1.13 | 0.561 | 0.946 |
| 48 | 0–5 | 2.63 | 1.92 | 0.435 | 0.947 |
| 49 | 0–5 | 3.91 | 1.27 | 0.497 | 0.946 |
| 50 | 0–5 | 3.60 | 1.67 | 0.326 | 0.948 |
| 51 | 0–5 | 3.99 | 1.01 | 0.592 | 0.946 |
| 53 | 0–5 | 3.10 | 1.30 | 0.720 | 0.945 |
| 55 | 0–5 | 3.68 | 1.30 | 0.478 | 0.947 |
| 56 | 0–5 | 3.58 | 1.63 | 0.316 | 0.948 |
| 57 | 0–5 | 3.14 | 1.63 | 0.535 | 0.946 |
| 58 | 0–5 | 3.71 | 1.46 | 0.458 | 0.947 |
| 59 | 0–5 | 3.82 | 1.40 | 0.561 | 0.946 |
| 60 | 0–5 | 2.74 | 1.73 | 0.463 | 0.947 |

were deleted due to poor item characteristics and redundancy. A second reliability analysis was done after deleting the identified 'problem' items in the scale. After deleting the items, the scale was composed of 40 items with good item characteristics. A new datasheet was created where diabetes self care management (DSCM) was measured using only the remaining 40 items. This new 40-item scale was tested for its psychometric characteristics, reliability, and validity. (See Table 5 for Descriptive Statistics and Reliability Estimates for the 40-item scale). The results indicated that the scale had high level of internal consistency (Cronbach's $\alpha = 0.947$) (See Table 6).

3.4. Validity testing of the 40-item DSMS

A correlation matrix was made to test the validity of the 40-item DSMS. This matrix showed that there was a strong correlation between Self Efficacy (SE) and Diabetes Self Care Management (DSCM) ($r = 0.8$; $P < 0.01$); and moderate correlation between diabetes self care agency (SCA) and DSCM (0.62 ; $P < 0.01$). Also, a weak correlation was found between diabetes knowledge and DSCM ($r = 0.26$). The results of these correlational tests were congruent with the correlational matrix of and the findings of Sousa et al. [3] where they reported both SE and SCA had direct relationship with DSCM, and that SE partially mediated the

relationship between SCA and DSCM. Also, diabetes knowledge had no direct relationship with DSCM.

4. Discussion

The aim of the study was to examine the reliability and item characteristics of the Diabetes Self Management Scale (DSMS). In this study, Item analysis for the 60 items of the Diabetes Self Management Scale (DSMS) was done and showed that other items might be problematic because they had low variability compared to the other items on the scale; and some items had a median of the highest possible score on the items (a possible ceiling effect).

The recommendations of Ferketich [9] to identify whether any given item should be retained or deleted were used to revise the DSMS. These recommendations included assessing the average correlations of the items, inter-item correlation matrix, corrected item-total correlation, alpha-if-item deleted, item validity estimate, and item variability. Ferketich [9] indicated that because scale validity is a function of its adequate measurement of an attribute, then each item in that scale should also be an adequate measure of that attribute. Item validity estimates can be obtained by correlating the score of an individual item with an outside criterion. So, the items of the DSMS scale were correlated with the total scores of SE to assess the validity of the items. The results of the correlation

Table 7
Pearson's correlations among Model Variables.

| | 40-Item DSMS | diabetes knowledge | self care agency | self efficacy |
|--------------------|--------------------|--------------------|--------------------|---------------|
| 40-Item DSMS | 1 | | | |
| diabetes knowledge | 0.262 ^a | 1 | | |
| self care agency | 0.629 ^b | 0.378 ^b | 1 | |
| self efficacy | 0.801 ^b | 0.251 ^a | 0.641 ^b | 1 |

^a Correlation is significant at the 0.05 level (2-tailed).

^b Correlation is significant at the 0.01 level (2-tailed).

showed that some items had relatively low validity compared to the other items on the DSMS scale. The item validity was also reviewed in the process of reviewing the items to determine which item to keep and which one to delete.

A total of 20 items were identified as 'problem' items and they were marked for deletion. Cronbach's α for the resulting 40-item scale showed a high level of internal consistency at 0.947, which exceeded the recommended minimum criterion of 0.70 or above for determining internal consistency [10].

To assess construct validity, the items of the scale should show consistency with the theory and the concepts as operationally defined [10]. This consistency can be tested by examining the item interrelationships and investigating the extent of the relationship between the item scores and external variables. In this study, the scores from the 40-item DSMS were correlated with the scores of the Diabetes Self Efficacy Scale (DSES), the Diabetes Knowledge Test (DKT), and The Appraisal of Self care Agency Scale Revised (ASAS-R). The relationship between Self Efficacy (SE), self care agency, diabetes knowledge, and Diabetes Self Care Management (DSCM) was addressed in the literature and in the Research Model for Diabetes Self Care Management. Our findings regarding the relationships and the strength of correlations were consistent with those addressed by the model. Therefore, the construct validity of the 40-item DSMS scale was supported.

5. Conclusion

A reliable and valid instrument that measures Diabetes Self Care Management has the potential to be a useful measure of self care management in clinical practice and research. In clinical practice, the revised measure can be used to screen individuals in respect to their performance of self care behaviors and activities. The revised scale also can help in developing individualized plans of care to promote performance of self care activities. In research, the new 40-item DSMS can be used to collect baseline and outcome data when implementing interventions to promote an individual's performance and engagement in self care management. When individuals achieve substantial levels of self care, they are more likely to attain better glycemic control, quality of life, general health status and well-being and to prevent the disease-related complications.

The 60 items of the DSMS were assessed using Ferkitech [9] recommendations for retaining or deleting items from a scale. The correlation matrices showed that a total of 20 items had poor item characteristics. These 20 items were deleted and the resulting 40-item scale was then assessed for reliability. The 40-item scale had high level of internal consistency (Cronbach's $\alpha = 0.947$). The validity of the 40-item scale was then assessed by using the scale in the assessment of the relationships among the concepts of the Research Model for Diabetes Self Care Management. The scores of the 40-item DSMS were strongly correlated with an outside criterion (Self Efficacy) that has theoretically supported relationship with Diabetes Self Care Management (See Table 7). This finding supports the validity of the 40-item DSMS.

6. Study limitations

Several study limitations were identified. Limitations were identified with the study design, the study was a descriptive cross-sectional design that may limit the generalizability of the findings. Final sample size and the convenience sample was another limitation because this type of sampling and data collection procedure may have confounding influence of alternative causes. The final sample size was relatively small to generalize the results of the psychometric testing and not sufficient to conduct factor analysis. Thus, factors analysis is needed for the scale.

Conflict of interest statement

No conflict of interest has been declared by the author.

Funding statement

This study received no funding.

Author contributions

Gharaibeh: undertook recruitment of participating centers and patients and managed the data. Takes responsibility for the paper as a whole.

Al_Smadi provided statistical advice on study design and analyzed the data.

Boyle: conceived the study and its design.

All authors contributed substantially to its revision.

Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.ijnss.2017.04.001>.

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