

Access this article online
Quick Response Code:

Website: www.jehp.net
DOI: 10.4103/jehp.jehp_139_22

# Development and psychometric properties of teamwork scale in resuscitation: A sequential exploratory mixed-method study

Mohammad Hosseini, Abbas Heydari<sup>1</sup>, Hamidreza Reihani<sup>2</sup>, Hossein Kareshki<sup>3</sup>

## Abstract:

**BACKGROUND:** Non-technical skills as a complement to technical skills have become increasingly important in cardio-pulmonary resuscitation, and teamwork is one of the most prominent of these skills. Because of the limited number of tools introduced and validated for measuring teamwork in resuscitation, this study was conducted to develop and evaluate the psychometric properties of the Teamwork Scale in Resuscitation (TSR).

**MATERIALS AND METHODS:** This study was a sequential exploratory mixed-method study and was conducted between March 2020 and April 2021 and in two phases. In the first phase (qualitative), semi-structured interviews were performed with resuscitation team members who were selected using a purposeful sampling method with maximum variation in terms of experience, level of education, age, and gender. Using directed qualitative content analysis, the data were analyzed and the primary item pool was developed. In the second phase (quantitative), assessing face, content, and construct validity as well as reliability via the internal consistency and stability, the psychometric properties of the instrument are evaluated.

**RESULTS:** The initial tool consisted of 54 items; after assessing the face validity, ten items were removed during content validity, and the final tool consisted of 44 items and three main categories including the essential prerequisites for resuscitation, leadership, and teamwork, which was scored based on a 5-point Likert scale from strongly disagree to strongly agree. The convergent validity and concurrent validity of the tool were confirmed. The reliability of the instrument was also confirmed using Cronbach's alpha test and re-test and the intra-class correlation coefficient (ICC) between raters.

**CONCLUSION:** The validity and reliability of TSR for measuring teamwork in resuscitation in a simulated environment are approved. Further studies are suggested for different contexts of resuscitation and with trained raters to evaluate its use in real resuscitation situations.

## Keywords:

Mixed-method study, psychometric properties, resuscitation, scale, teamwork

## Introduction

Teamwork is an essential element in providing safe and effective patient care.<sup>[1,2]</sup> It is a concept that is easy to understand but not easy to define.<sup>[3]</sup> It has become clear that teamwork is related to team performance, regardless of team or task characteristics.<sup>[4]</sup> The ability to function

effectively in critical situations such as cardio-pulmonary resuscitation when there is a short time to manage the situation is very important.<sup>[1]</sup> Teamwork has been identified as a key factor in managing emergency situations, and the lack of teamwork will be a primary point of vulnerability for the safety of care.<sup>[5,6]</sup> Differences in culture, resources, and training can affect teamwork training in resuscitation.<sup>[7]</sup> There

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow\_reprints@wolterskluwer.com

**How to cite this article:** Hosseini M, Heydari A, Reihani H, Kareshki H. Development and psychometric properties of teamwork scale in resuscitation: A sequential exploratory mixed-method study. *J Edu Health Promot* 2023;12:10.

Department of Medical Surgical Nursing, School of Nursing and Midwifery, Mashhad University of Medical Sciences, Mashhad, Iran, <sup>1</sup>Nursing and Midwifery Care Research Center, Mashhad University of Medical Sciences, Mashhad, Iran, <sup>2</sup>Department of Emergency Medicine, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran, <sup>3</sup>Department of Psychology, Faculty of Educational Sciences and Psychology, Ferdowsi University of Mashhad, Iran

## Address for correspondence:

Prof. Abbas Heydari, Professor of Nursing, Nursing and Midwifery Care Research Center, Mashhad University of Medical Sciences, Mashhad, Iran.  
E-mail: heidarya@mums.ac.ir

Received: 28-01-2022  
Accepted: 12-04-2022  
Published: 31-01-2023

are currently some teamwork-measuring tools available for critical situations; however, it should be noted that choosing the right tool depends entirely on the user context.<sup>[8-10]</sup> In addition, the concerning team, teamwork, development strategies, and functional characteristics of the task play an important role in the generalization of study results.<sup>[2]</sup> Measuring teamwork allows examining the actual performance of the resuscitation team in the real world and providing feedback; it is also well-suited to the simulated environment, thus facilitating the transfer of learning to the clinical setting.<sup>[1]</sup>

Teamwork training and strengthening team performance improve patient safety and the effectiveness of care; in this regard, programs such as Crew Resource Management (CRM) and Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS) have received more attention from clinicians and researchers.<sup>[11]</sup> Studies have shown that time pressure, multi-tasking, and problems in teamwork during resuscitation are the most common causes of errors during resuscitation.<sup>[12,13]</sup> Researchers believe that in choosing a model to improve teamwork, one should also pay attention to the specific conditions of that team.<sup>[14]</sup> Existing teamwork-related models, designed and validated for non-resuscitation situations, can provide a useful framework for understanding team needs. However, the chosen model needs to be adapted to the specific requirements of that team, the team tasks, and the environment in which the team works.<sup>[15]</sup> Programs, models, and theories are often considered as general principles and guidelines for work, but at the performance level, we often need valid and reliable tools to more rigorously measure behaviors and practices.<sup>[16]</sup> The Team Emergency Assessment Measure (TEAM) and the Observational Skill-based Clinical Assessment tool for Resuscitation (OSCAR) are among the few tools designed to measure teamwork in resuscitation for the simulated environment.<sup>[17]</sup> Researchers have pointed out that culture and the availability of facilities can affect teamwork in resuscitation and should be considered.<sup>[7]</sup> Given the importance of considering the potential impact of culture and other environmental factors on behavioral markers, it is necessary to design and validate tools that measure behavioral concepts in accordance with the conditions of that community. Since there is currently no standard tool for measuring teamwork in resuscitation in Iran, this study was conducted to develop and evaluate the psychometric properties of the Teamwork Scale in Resuscitation (TSR).

## Materials and Methods

### Study design and setting

This methodological research was a sequential exploratory mixed-method study and carried out in

two qualitative and quantitative stages from 2018 to 2021. In the first stage, a qualitative study was conducted to generate a pool of items and then develop an initial TSR. The four-step model of Waltz *et al.* (2010)<sup>[18]</sup> was used to design the tool at this stage. The main focus was on directed qualitative content analysis of interviews with the method of Elo and Kingas<sup>[19]</sup> as well as field notes, integrative,<sup>[3]</sup> and literature reviews. In the second stage, a quantitative study was conducted to evaluate the psychometric properties of the instrument including face, content, construct validity, and reliability of the instrument. Because in this study the qualitative stage takes precedence over the quantitative stage in terms of time, the quantitative stage weighs more because of the volume of work, and therefore, its symbol is as follows:

Qualitative study (qual) → Quantitative study (Quant)

### Study participants and sampling

We held 16 semi-structured in-depth interviews with resuscitation team members (nurses and emergency medical physicians) who were selected using the purposeful sampling method with maximum variation respecting participants' age, work experience, and educational level. Table 1. Shows the general demographic of participants at the first phase of the study.

### Data collection tool and technique

In-depth semi-structured interviews were the predominant methods of data collection in the qualitative stage of the study. According to participants' preferences, interviews were held in a private room at their workplace. The interviewer introduced himself to the participants, explained the subject and purpose of the interview, and after ensuring the confidentiality of the information and obtaining written informed consent conducted the interview starting with the main question: "How is your experience or understanding of teamwork in resuscitation?"; then the interview was directed to questions related to the main concepts of teamwork based on the TeamSTEPPS model, for example: "Describe your experience of how the team leader led the resuscitation team" or "how is the communication formed between the members of the resuscitation team?". In addition, probing questions were asked to follow the participants' thoughts, such as please describe in detail your experiences of well-remembered resuscitation cases or explain the factors affecting teamwork or the performance of the resuscitation team. Also, field note was performed at the time of the interviews and at other times to observe the teamwork and interaction of members in cases of real resuscitation. The average duration of interviews was 40 minutes. The interviews were transcribed and typed the same day after recording and coded as soon as possible. At the end of the interview, participants

**Table 1: Demographic information of the participants in the qualitative phase**

Gender	Age	Degree	Work experience in other departments (years)	Work experience in the resuscitation department (years)	Interview time (minutes)
Male	32	BSN*	0	6	42
Female	39	BSN	10	3	44
Female	32	BSN	4	4	36
Male	29	BSN	3	5	40
Male	29	MSN**	3	1	46
Female	32	BSN	6	2	51
Female	36	BSN	2	10	65
Female	32	BSN	3	3	40
Female	30	BSN	1	4	45
Male	45	EMR***	0	17	22
Male	28	BSN	0	6	35
Male	34	BSN	0	8	38
Female	32	EMR	0	6	25
Male	34	MSN	0	8	39
Female	33	BSN	0	7	36
Male	29	EMR	0	5	41
Average work experience of members				Average interview time	
7.94 (SD* = 3.39) years				40.31 (SD=9.79) min	

\*Bachelor of Science in Nursing, \*\*Master of Science in Nursing, \*\*\*Emergency Medicine Resident. Standard Deviation

were asked if they wanted to add anything else about teamwork in resuscitation.

We used the Elo and Kingas (2008) method for qualitative content analysis, which consists of three main phases of preparation, organization, and reporting of results for both inductive and deductive approaches.<sup>[19]</sup> Four teachable-learnable skills of TeamSTEPPS (core competencies) in the deductive approach including communication, leadership, situation monitoring, and mutual support<sup>[20]</sup> guided the interviews in the inductive approach. After extracting the initial codes and identifying the main categories and other sub-categories of teamwork in resuscitation at the end of the organizing phase, we performed an integrative review of teamwork elements in resuscitation by searching PubMed, Scopus, Web of Science, and Embase databases, as well as the Google Scholar search engine from November 2015 to March 2020 and a literature review to identify existing or similar tools to complete the data and item generation. No article was found searching for scientific databases in Persian. The most relevant keywords used for integrative review and literature review were a combination of "team\*" and "resuscitation". The codes obtained from integrative and literature reviews and field notes were carefully compared with the codes and categories formed at the organizing phase and then placed in the right category. The added codes did not change the emerged categories and sub-categories. Finally, theoretical and operational definitions were provided for the sub-categories and main categories based on elements of each category. A combination of qualitative and quantitative stages of the study was performed with a connecting strategy. This means that the theoretical

and operational definitions derived from qualitative stage data are used to construct the items, and the first connection point will be the collection of quantitative data. The data from the interviews were analyzed using MAXQDA software version 20.

The first draft of the questionnaire was reviewed several times by the research team to ensure the correct wording of the items, the elimination of duplicate sentences, and the correct order of the items. The questionnaire was scored based on a 5-point Likert scale from strongly disagree to strongly agree (1 = strongly disagree, 2 = disagree, 3 = have no opinion, 4 = agree, 5 = strongly agree). The target group of this questionnaire is emergency medicine physicians and nurses familiar with resuscitation who, in the role of raters, will measure the teamwork in resuscitation. The questionnaire consists of 44 items, so the possible total score of the instrument is 44–220, and higher scores indicate stronger teamwork in the resuscitation team.

For rigor of study, four criteria including credibility, confirmability, transferability, and dependability recommended by Elo and Kingas (2014) were considered.<sup>[21]</sup> The researcher's long-term engagement period (13 months) in the research setting as a residency course assured credibility. By member checking and peer checking, data accuracy is confirmed and the interpretation of findings is verified by an external auditor. Using the supplementary opinions of experts in qualitative research as well as a specific and detailed report of the research process satisfied the confirmability. Also, by accurately and clearly explaining the study steps, the TeamSTEPPS model, and the method used,

transferability was achieved. Moreover, by continuous comparative analysis of the findings, dependability was ensured.

In face validity, an objective judgment is made about the construct of the tool and indicates the tool's relevance to the aim of the study, the wording of the questions, how to express the phrases, and the understanding of the concept intended by the researcher. Face validity was achieved both quantitatively and qualitatively. First, five nurses and five emergency medicine physicians working in the hospital's emergency department were asked to comment on the difficulty, ambiguity, and relevancy of the items. They were asked to comment on the relevance of the items to the main research question and items' wording and if necessary state their suggested items or corrections. For quantitative face validity, ten participants were asked to comment on the importance of items in the 5-point Likert scale from 1 (not important) to 5 (completely important). Then, the item impact scores [importance × frequency (%)] for each item were calculated. In this formula, frequency is the percentage of ten participants who ascribed a score of 4 or 5 to the item and importance is the mean score of the item. An impact score equal to or greater than 1.5 is considered suitable, and that item can remain in the questionnaire.<sup>[22]</sup>

For qualitative content validity, the opinions of 12 experts with research backgrounds in emergency and instrument development were surveyed. Their corrective comments on item allocation, grammar, wording, and scoring of each item were gathered. Then, items were edited by changing, adding, or removing words. For assessing the quantitative content validity, while providing a brief introduction about teamwork in resuscitation, theoretical and operational definitions of main categories and sub-categories related to teamwork in resuscitation, which was obtained in the qualitative stage of the study, were also provided to them. They were asked to comment on the relevance of the items and to provide corrective comments where necessary. Experts were asked to comment on the relevance degree of the items to teamwork in resuscitation in a 4-point Likert scale (1 = irrelevant, 2 = partially relevant, 3 = highly relevant, 4 = completely relevant). Then, the content validity index (CVI) was calculated by dividing the total number of experts who scored 3 or 4 by the total number of experts who rated that item. The CVI was calculated for each item of the questionnaire (item level or I-CVI) and the global scale (scale level or S-CVI). By calculating the average CVI of all items, S-CVI was calculated. The items with a CVI of 0.78 and higher were considered acceptable.<sup>[23]</sup> Also, experts were asked to respond in the three-degree range of 1 = essential, 2 = useful but not essential, and 3 = essential about the necessity of items in the 55-item questionnaire. Based on the answers of

experts, the content validity ratio (CVR) was calculated using its equation  $((N_e - N/2)/(N/2))$ .  $N_e$  shows the number of experts who declared the item necessary and  $N$  shows the number of experts. According to the Lawshe table, the minimum acceptable value of CVR for 12 experts is 0.56.<sup>[24]</sup>

Construct validity is the degree to which a tool conforms to a theory. It can be measured in a variety of ways, including the correlation of a new tool with a validated tool.<sup>[25]</sup> We had no valid tool to measure teamwork in resuscitation in the Persian language, so we intended to examine whether our scale behaves as the TEAM score (convergent validity). For this purpose, immediately after showing each of the films related to resuscitation, the raters first filled in the TEAM questionnaire and then TSR. We also used the global score in the TEAM tool (item 12), which is related to the overall score that raters assign to the teamwork of the resuscitation team members to check for concurrent validity.

The reliability of the dimensions of teamwork in resuscitation was assessed by examining internal consistency through Cronbach's alpha. Cronbach's alpha values greater than 0.7, 0.8, and 0.9 are considered acceptable, good, and excellent, respectively.<sup>[26]</sup> Inter-rater reliability expressed by intra-class correlation coefficients (ICCs) measures the stability and correlation of scores between different observers or raters of a subject; in other words, it indicates the coefficient of agreement of the raters in achieving similar results. ICCs below 0.5, 0.5–0.75, and 0.75 and above are considered as poor, moderate, and good, respectively.<sup>[27]</sup> Inter-rater reliability was assessed by measuring ICC, with the two-way random effects model and the consistency type. Twelve students and Ph.D. candidates in nursing and midwifery, in two stages 1 week apart, evaluated and graded five carefully prepared videos on resuscitation in a simulated environment with the TEAM score and TSR. Almost half of the raters were Ph.D. candidates with a background in teaching or working in the emergency department. Both instruments were given to them 3 days before the first stage of the test, and the purpose of the study was explained. Also, they entered the study voluntarily. Before the start of the test, they all took a 2-hour non-technical resuscitation skill training and took the test immediately afterward. The testing and re-testing of the instrument were held in a room with a quiet space, suitable and equipped with good audio-visual facilities, including a large screen, in the School of Nursing and Midwifery.

Stability refers to the degree to which raters achieve similar results at two different times. ICC with a confidence level of 95% was used to examine test-retest reliability. An ICC over 0.4 was considered as the acceptable level for stability.<sup>[28]</sup>

The simplicity of a tool is achieved by calculating the average time it takes to fill it, and the percentage of unanswered items is also important.

**Ethical considerations**

The Ethics Committee of Mashhad University of Medical Sciences approved this study (Approval ID: IR.MUMS.REC.1398.285). Explaining the purpose of the study to the participants and assuring them that their information was confidential, informed consent was obtained, and they were told that they could leave the study at any time if they did not wish to participate.

**Results**

At the first phase of this sequential exploratory mixed-method study, qualitative data were collected from 16 in-depth semi-structured interviews with members of the resuscitation team, including nurses and emergency medicine physicians working in the emergency department of a big university hospital in Mashhad, Iran. The demographic information of the participants in the qualitative phase is shown in Table 1. Performing the directive qualitative content analysis on the typed texts of the interviews, 1181 initial codes were obtained and three main categories including “essential prerequisites for resuscitation”, “leadership”, and “teamwork” emerged. To enrich and complete the item pool, four field notes, an integrative review of elements of teamwork in resuscitation, and a literature review on related instruments were performed, resulting in the addition of 123, 20, and 56 additional codes, respectively. The instruments assessed in the literature review included TEAM,<sup>[29]</sup> OSCAR,<sup>[30]</sup> Emergency Team Dynamics (ETD),<sup>[31,32]</sup> Mayo high-performance teamwork scale (Mayo HPTS),<sup>[33]</sup> and University of Texas Behavioral Markers for Neonatal Resuscitation (UT BMAF).<sup>[34]</sup> After detailed analysis, their items were added to the item pool in the form of codes. According to the fourth steps of Waltz *et al.*'s model,<sup>[18]</sup> after forming the item pool, arranging the items, and scoring rules, the initial version of the TSR was designed.

In the second stage of the study, the psychometric properties of the instrument were analyzed, and for this purpose, face validity, content, structure, and reliability were evaluated.

**Face validity**

In qualitative face validity, five nurses and five emergency medicine residents of resuscitation team members reviewed TSR for appropriateness and relevance of items; then, items were corrected based on their comments. Quantitative face validity showed that all items had an impact score higher than 1.5, so they remained in TSR.

**Content validity**

After assessing quality content validity, according to experts' comments, eight items were revised. Calculating CVI by collecting experts' comments on the simplicity, clarity, and relevance of the items showed that TSR has a good CVI (higher than 0.78). In calculating the CVR, based on the Lawshe table, taking into account the number of specialists (12), the CVR should be at least 0.56; accordingly, the ten items that received the lowest score were removed from TSR and the 44 items remained. Essential prerequisites for resuscitation, leadership, and teamwork categories include 19, 9, and 16 questions, respectively [Figure 1]. The translation of the TSR from Persian to English was performed, and the translation was approved by the authors of the article. The average of CVI scores (S-CVI/Ave) was 0.96, and the S-CVI/UA was 0.45. The Item-level CVI (I-CVI) range of the TSR was between 0.78 and 1. The CVR for the whole instrument was 0.84, with a range of 0.67–1. Because of the CVI and CVR values, the TSR has good content validity.

**Construct validity**

To measure the construct validity and reliability of TSR, 12 students and Ph.D. candidates in nursing and midwifery as raters assessed and rated five carefully prepared videos on resuscitation with the TEAM score and TSR in two stages of testing and re-testing with an interval of 1 week. Raters' demographic information is shown in Table 2.

**Convergent validity and concurrent validity**

The raters rated both the teamworks in the resuscitation with both TEAM and TSR tools in the test phase. The degree of correlation between these two tools shows convergent validity [Table 3]. The correlation between the two tools was weak for film 5, moderate for films 2 and 3, and strong for films 1 and 4. In general, TSR had an acceptable level of correlation with the TEAM tool, and therefore, the convergent validity of the TSR was confirmed.

**Table 2: Raters' demographic information**

Gender	Age	Educational degree	Work experience (years)
Male	45	Ph.D. Candidate in Nursing	20
Male	47	Ph.D. Candidate in Nursing	19
Male	46	Ph.D. student in Nursing	23
Male	37	Ph.D. Candidate in Nursing	14
Male	30	Ph.D. student in Nursing	5
Female	38	Ph.D. student in Nursing	15
Female	33	Ph.D. Candidate in Nursing	5
Female	31	Ph.D. student in Nursing	4
Female	40	Ph.D. student in Nursing	15
Female	41	Ph.D. student in Nursing	15
Female	40	Ph.D. Candidate in Midwifery	15
Female	34	Ph.D. student in Nursing	10

Items	Strongly disagree	Disagree	Have no opinion	Agree	Strongly agree
<b>Essential prerequisites for resuscitation</b>					
Team members feel responsible for performing tasks.					
While treating the patient's companions respectfully, the companions are properly informed about the patient's condition.					
They are serious during resuscitation and have control over their behaviors.					
The members and the team leader accept the logical suggestions of the other members					
Team members and leaders adhere to the orders.					
The professional literacy of the team leader is up-to-date and he/she uses it well in practice.					
The professional literacy of the team members is up to date and they follow the protocols and principles of work.					
Team members play their role and responsibilities well.					
Team members and leaders are capable of performing clinical skills.					
They have a high operating speed in doing things.					
Team members are on time and do not waste time doing things.					
The team leader acts authoritatively.					
The behavior of the team leader is friendly.					
The members listen to the orders of the team leader and execute the orders on time.					
The security team supports the team members well.					
The atmosphere in the team is positive.					
Team composition is specific, standard and consistent.					
Organizing a resuscitation room is appropriate.					
The team has a strong support system.					
<b>Leadership</b>					
The team leader adheres to the treatment protocol with time management.					
The team leader is completely focused on the treatment and oversees all changes in the patient's condition.					
The team leader gives only the necessary instructions and writes at the earliest opportunity.					
In an emergency, the team leader makes the final decision quickly and decisively and announces it aloud.					
The team leader clearly shares information and goals with team members.					
The team leader follows the results of the actions and gives feedback to the team members at the appropriate time.					
The team leader organizes and coheses the team.					
The team leader is familiar with the members, their roles and their capabilities.					
The team leader does the time management well.					
<b>Teamwork</b>					
Team members monitor each other's accuracy.					
Team members monitor the correctness of implementation and the effectiveness of processes and results.					
Team members seek to avoid or contain error.					
Complete monitoring, especially cardiac and respiratory monitoring, is performed and the expected results are regularly analyzed.					
They pay attention to the readiness and adjustment of tools and equipment and any action that facilitates the work.					
Team members pay attention to the ability of other members to perform their duties.					
Team members are coordinated in doing things.					
They use short, accurate, academic language in a respectful, persuasive and encouraging tone.					
Communication between team members is serious, appropriate and respectful.					
Team members clearly hear the team leader's order and the announcement of the order, as well as the execution and outcome of the order.					
There is only one team leader who delivers instructive or friendly messages to team members.					
In case of ambiguity or doubt on the orders of the team leader, team members request confirmation or repetition of the order.					
There is mutual trust between team members.					
Team members are familiar with the characteristics, work experience and skills of other members.					
To maintain the strength of team members, there is workload management.					
There is an atmosphere of cooperation between team members.					

Figure 1: Teamwork Scale in Resuscitation (TSR)

The degree of agreement between the TSR tool and the global score of the team tool (12<sup>th</sup> item) indicates that except in film 5, there is a moderate correlation between them [Table 3], and therefore, the concurrent validity of the TSR is confirmed.

**Reliability**

Measuring the internal consistency of TSR by Cronbach’s alpha coefficients in test and re-test phases and the inter-class correlations, ranging from 0.61 to 0.75, showed that the reliability of the scale was at a good level and none of the items had an inter-item correlation coefficient of less than 0.3 [Table 4]. Also, the degree of agreement or correlation between the raters’ measurements was assessed by ICC; the results showed that the raters had a moderate to good agreement for measuring teamwork in resuscitation [Table 4].

Test and re-test were used to check the stability of the TSR. Seven raters showed average to good scoring stability in the two stages of testing and re-testing, but five evaluators had weak scoring stability (raters 4, 5, 6, 10, and 12) [Table 5].

The average time for filling out the TSR was 15 minutes in the range of 12–20. There were no unanswered questions in both the test and re-test stages.

**Discussion**

The present study was designed and implemented to develop and validate a tool for measuring teamwork in resuscitation. As far as we know, this is the first study related to resuscitation, with a special emphasis on the experiences of resuscitation team members. Medical staff members have valuable experiences that should be considered when designing tools. In this mixed-method study, in addition to the directed qualitative content analysis of in-depth semi-structured interviews with resuscitation team members, an integrative review study, a literature review, and four field notes were conducted to ensure the comprehensiveness of the analysis. TSR with three categories of essential prerequisites for resuscitation, leadership, and teamwork has 44 questions. Examining the psychometric properties of the TSR, it was found that the tool has suitable face, content, and structure validity; also, the reliability of the TSR is at an appropriate level.

One of the benefits of developing valid scales is that they can be used to develop more specific, comprehensive, and targeted educational programs.<sup>[35]</sup> Standard tools can also be used in training programs for clinical staff.<sup>[36]</sup> Therefore, having a valid and reliable scale for

**Table 3: Correlation of TSR, TEAM, and TEAM’s global score with Pearson correlation coefficient in the test stage**

	FILM1		FILM2		FILM3		FILM4		FILM5	
	TEAM	TEAM’s global score	TEAM	TEAM’s global score	TEAM	TEAM’s global score	TEAM	TEAM’s global score	TEAM	TEAM’s global score
Film1										
TSR	0.862 (0.000)	0.547 (0.066)								
Film2										
TSR			0.603 (0.038)	0.501 (0.097)						
Film3										
TSR					0.696 (0.012)	0.538 (0.071)				
Film4										
TSR							0.768 (0.004)	0.593 (0.042)		
Film5										
TSR									0.017 (0.957)	0.329 (0.296)

**Table 4: Cronbach’s alpha coefficients and intra-class and inter-class correlations in the TSR**

Films	Test			Re-test		
	α	ICC	Inter-class correlation (range)	α	ICC	Inter-class correlation (range)
Film1	0.688	0.532-0.808	0.69 (0.53-0.81)	0.657	0.485-0.790	0.721 (0.58-0.83)
Film2	0.754	0.632-0.849	0.75 (0.63-0.85)	0.634	0.450-0.776	0.680 (0.52-0.80)
Film3	0.697	0.546-0.814	0.70 (0.55-0.81)	0.559	0.338-0.730	0.608 (0.41-0.76)
Film4	0.701	0.551-0.816	0.71 (0.55-0.82)	0.559	0.398-0.754	0.661 (0.49-0.79)
Film5	0.768	0.652-0.857	0.77 (0.65-0.86)	0.751	0.626-0.846	0.721 (0.58-0.83)
Overall	0.725	0.668-0.776		0.648	0.575-0.713	

measuring teamwork in resuscitation has undeniable benefits for education, research, and clinical practice. By assessing teamwork skills in resuscitation, we have the opportunity to assess and evaluate the skills needed to maintain patient safety and provide a high-quality resuscitation.<sup>[1]</sup>

In this study, we explored teamwork as a general and context-related concept. That is, inter-personal interactions alone were not enough. The experiences of the members of the resuscitation team in this study showed that the requirements of the workplace and professional requirements as sub-categories of prerequisites for resuscitation should be observed to integrate leadership and teamwork skills to have more effective results. Communication skills, situation monitoring, and mutual support were included in the teamwork category based on the directed quality content analysis process, but the leadership category (another concept from TeamSTEPPS) remained the main category because of the variety and a large number of extracted codes specific to this category.

Teamwork and leadership formed two of the three main categories of the TSR. There are several studies on the importance of teamwork and leadership in resuscitation, which emphasize the importance of these two categories in line with the results of the present study. For example, Hunziker *et al.*<sup>[37]</sup> noted in their study that teamwork and leadership training in resuscitation will improve the team's future performance in resuscitation and that these two skills are included in advanced cardio-pulmonary resuscitation guidelines.

According to McKay *et al.*'s<sup>[17]</sup> study (2012), the TEAM and OSCAR tools designed to measure teamwork in the simulated environment were well correlated and their reliability was slightly different. These results are consistent with the results of the present study; in our study, the correlation between scores of TSR and TEAM was good and the reliability of TSR was at an appropriate level except in some cases [Table 5]. McKay pointed out in his study that using raters who were not proficient in rating was effective on the reliability of the tool.<sup>[17]</sup> We have reached the same result, that is, the use of raters who are not properly trained in rating may affect the reliability of the tool. The number of items in the TEAM is less than that in the OSCAR and the TSR, but as McKay points out, the OSCAR is more suitable for achieving a more detailed teamwork assessment,<sup>[17]</sup> and we make the same claim for the TSR. In our study, in addition to the comprehensive literature review, a qualitative study has been used as a basis for study; also, considering the more comprehensive definition of teamwork in resuscitation, special attention has been paid to context (resuscitation situations), and this can be considered as the strength

**Table 5: Correlation between raters' scores of TSR in the test and re-test phases**

	Film1		Film2		Film3		Film4		Film5	
	Cronbach's $\alpha$	ICC	Cronbach's $\alpha$	ICC	Cronbach's $\alpha$	ICC	Cronbach's $\alpha$	ICC	Cronbach's $\alpha$	ICC
Rater1	0.736	0.516-0.856	0.553	0.182-0.756	0.713	0.475-0.844	0.587	0.243-0.775	0.531	0.140-0.744
Rater2	0.617	0.299-0.791	0.556	0.187-0.758	0.572	0.215-0.766	0.484	0.055-0.719	0.784	0.605-0.882
Rater3	0.782	0.600-0.881	0.669	0.393-0.819	0.187	-0.489-0.557	0.694	0.438-0.833	0.652	0.362-0.810
Rater4	0.470	0.029-0.711	0.487	0.061-0.720	0.285	-0.310-0.610	-0.129	-1.070-0.384	0.516	0.113-0.736
Rater5	-0.426	-1.613-0.222	-0.437	-1.634-0.216	0.033	-0.772-0.472	0.065	-0.714-0.490	0.302	-0.279-0.619
Rater6	0.531	0.140-0.744	0.134	-0.587-0.528	0.541	0.158-0.749	0.455	0.001-0.703	0.468	0.025-0.710
Rater7	0.603	0.272-0.783	0.901	0.819-0.946	0.781	0.598-0.880	0.793	0.621-0.887	0.851	0.728-0.919
Rater8	0.625	0.313-0.795	0.510	0.103-0.733	0.561	0.195-0.760	0.061	-0.944-0.421	0.458	0.006-0.704
Rater9	0.523	0.126-0.740	0.495	0.075-0.725	0.719	0.484-0.846	0.212	-1.222-0.338	-0.647	-2.019-0.101
Rater10	-0.247	-1.286-0.319	-0.124	-1.060-0.387	-0.237	-1.268-0.325	0.167	-1.138-0.363	0.074	-0.697-0.495
Rater11	0.577	0.225-0.769	0.607	0.280-0.786	0.723	0.493-0.849	0.558	0.496-0.635	0.762	0.563-0.870
Rater12	0.369	-0.157-0.655	0.395	-0.109-0.670	0.226	-0.419-0.578	0.398	-0.103-0.672	-0.549	-1.839-0.155



of the study. The experiences of resuscitation team members, who are directly exposed to numerous cases of resuscitation, are a rich, valuable, and first-hand source of information that has been used in the first stage of this study to design a teamwork scale in resuscitation. As far as we know, this is the first study in this field performed with a mixed-method methodology and starting with a qualitative study in the first stage.

### Limitation and recommendation

The most important limitation of the study is the lack of professional raters to measure teamwork in resuscitation, which can affect the reliability of the instrument. To solve this problem, we provided the assessment tools to the raters 3 days before the test, explained the purpose of the study, and answered their questions. Also, to further prepare them, during a 2-hour training class just before the test, we taught non-technical skills and reviewed two articles on TEAM and OSCAR.

In this study, the selected films included four adult resuscitation scenarios and one neonatal resuscitation scenario. In future studies, it is suggested to differentiate between different scenarios and compare the results. It is also possible to make a comparison between trained raters and raters who have not received special training.

### Conclusion

The TSR, which has been developed to measure teamwork in resuscitation, has good validity and reliability. This tool can be used to evaluate teamwork in resuscitation in a simulated environment and based on the results suggest appropriate feedback for the education and training of students or members of the resuscitation team. Using professional raters and repeating the study in different contexts of resuscitation, different cultural environments while providing more information about the reliability and validity of the TSR will make it possible to use it in real resuscitation.

### Acknowledgements

This study was written as a part of the PhD dissertation in nursing, which was registered at Mashhad University of Medical Sciences with the code No. of 981118. The authors would like to thank all of participants for taking part in this study and sharing their experiences.

### Financial support and sponsorship

This study was financially supported by the Deputy of Research and Technology of Mashhad University of Medical Sciences.

### Conflicts of interest

There are no conflicts of interest.

## References

1. Dirks JL. Effective strategies for teaching teamwork. *Crit Care Nurse* 2019;39:40-7.
2. Dietz AS, Pronovost PJ, Mendez-Tellez PA, Wyskiel R, Marsteller JA, Thompson DA, *et al.* A systematic review of teamwork in the intensive care unit: What do we know about teamwork, team tasks, and improvement strategies? *J Crit Care* 2014;29:908-14.
3. Hosseini M, Heydari A, Reihani H, Kareshki H. Elements of teamwork in resuscitation: An integrative review. *BEAT* 2022;10:95-102.
4. Schmutz JB, Meier LL, Manser T. How effective is teamwork really? The relationship between teamwork and performance in healthcare teams: A systematic review and meta-analysis. *BMJ Open* 2019;9:e028280.
5. Johnson SL, Haerling KA, Yuwen W, Huynh V, Le C. Incivility and clinical performance, teamwork, and emotions: A randomized controlled trial. *J Nurs Care Qual* 2020;35:70-6.
6. Hosseini M, Heydari A, Reihani HR, Kareshki H. Resuscitation team members' experiences of teamwork: A qualitative study. *IJNMR* 2022;27:439-45.
7. Perry MF, Seto TL, Vasquez JC, Josyula S, Rule AR, Rule DW, *et al.* The influence of culture on teamwork and communication in a simulation-based resuscitation training at a Community Hospital in Honduras. *Simul Healthc* 2018;13:363-70.
8. Boet S, Etherington N, Larrigan S, Yin L, Khan H, Sullivan K, *et al.* Measuring the teamwork performance of teams in crisis situations: A systematic review of assessment tools and their measurement properties. *BMJ Quality & Safety* 2019;28:327-37.
9. Ramazani J, Hosseini M. Comparison of the predictive ability of the pediatric risk of mortality III, pediatric index of mortality3, and pediatric logistic organ dysfunction-2 in medical and surgical intensive care units. *J COMPR PED* 2019;10:e82830.
10. Ramazani J, Hosseini M. Prediction of ICU mortality in critically ill children: Comparison of SOFA, GCS, and FOUR score. *Med Klin Intensivmed Notfmed* 2019;114:717-23.
11. Buljac-Samardzic M, Doekhie KD, van Wijngaarden JD. Interventions to improve team effectiveness within health care: A systematic review of the past decade. *HRH* 2020;18:1-42.
12. Ivatury RR, Guilford K, Malhotra AK, Duane T, Aboutanos M, Martin N. Patient safety in trauma: Maximal impact management errors at a level I trauma center. *J Trauma* 2008;64:265-72.
13. Lubbert PH, Kaasschieter EG, Hoorntje LE, Leenen LP. Video registration of trauma team performance in the emergency department: The results of a 2-year analysis in a level 1 trauma center. *J Trauma* 2009;67:1412-20.
14. Gaba DM, Howard SK, Fish KJ, Smith BE, Sowb YA. Simulation-based training in anesthesia crisis resource management (ACRM): A decade of experience. *S&G* 2001;32:175-93.
15. Marshall S. The use of cognitive aids during emergencies in anesthesia: A review of the literature. *Anesth Analg* 2013;117:1162-71.
16. Cooper S, Cant R, Connell C, Sims L, Porter JE, Symmons M, *et al.* Measuring teamwork performance: Validity testing of the Team Emergency Assessment Measure (TEAM) with clinical resuscitation teams. *Resuscitation* 2016;101:97-101.
17. McKay A, Walker ST, Brett SJ, Vincent C, Sevdalis N. Team performance in resuscitation teams: Comparison and critique of two recently developed scoring tools. *Resuscitation* 2012;83:1478-83.
18. Waltz CF, Strickland OL, Lenz ER. *Measurement in Nursing and Health Research*. Springer Publishing Company; 2010.
19. Elo S, Kyngas H. The qualitative content analysis process. *J Adv Nurs* 2008;62:107-15.
20. King HB, Battles J, Baker DP, Alonso A, Salas E, Webster J,

- et al.* TeamSTEPPS™: Team strategies and tools to enhance performance and patient safety. *Advances in Patient Safety: New directions and alternative approaches (Vol 3: Performance and tools)*. 2008.
21. Elo S, Kääriäinen M, Kanste O, Pölkki T, Utriainen K, Kyngäs H. Qualitative content analysis: A focus on trustworthiness. *SAGE Open* 2014;4:2158244014522633.
  22. Hajizadeh E, Asghari M. *Statistical methods and analyses in health and biosciences a research methodological approach*. Jahade Daneshgahi Publications; 2011.
  23. Lynn MR. Determination and quantification of content validity. *Nurs Res* 1986;35:382-5.
  24. Lawshe CH. A quantitative approach to content validity. *Personnel Psychology* 1975;28:563-75.
  25. Ginty A. Construct validity. *Encyclopedia of Behavioral Medicine*. New York: Springer New York; 2013.
  26. Pallant J. *SPSS Survival Manual*. UK: McGraw-Hill Education; 2013.
  27. Portney LG, Watkins MP. *Foundations of Clinical Research: Applications to Practice*. NJ: Pearson/Prentice Hall Upper Saddle River; 2009.
  28. Baumgartner TA, Chung H. Confidence limits for intraclass reliability coefficients. *MPEES* 2001;5:179-88.
  29. Cooper S, Cant R, Porter J, Sellick K, Somers G, Kinsman L, *et al.* Rating medical emergency teamwork performance: Development of the Team Emergency Assessment Measure (TEAM). *Resuscitation* 2010;81:446-52.
  30. Walker S, Brett S, McKay A, Lambden S, Vincent C, Sevdalis N. Observational Skill-based Clinical Assessment tool for Resuscitation (OSCAR): Development and validation. *Resuscitation* 2011;82:835-44.
  31. Cooper S, Wakelam AJR. Leadership of resuscitation teams: 'Lighthouse Leadership' 1999;42:27-45.
  32. Guise JM, Deering SH, Kanki BG, Osterweil P, Li H, Mori M, *et al.* Validation of a tool to measure and promote clinical teamwork. *Simul Healthc* 2008;3:217-23.
  33. Malec JF, Torsher LC, Dunn WF, Wiegmann DA, Arnold JJ, Brown DA, *et al.* The mayo high performance teamwork scale: Reliability and validity for evaluating key crew resource management skills. *Simul Healthc* 2007;2:4-10.
  34. Thomas EJ, Sexton JB, Helmreich RL. Translating teamwork behaviours from aviation to healthcare: Development of behavioural markers for neonatal resuscitation. *Qual Saf Health Care* 2004;13 (Suppl 1):i57-64.
  35. Shakibazadeh E, Sabouri M, Mohebbi B, Tol A, Yaseri M. Validity and reliability properties of the Persian version of perceived health competence scale among patients with cardiovascular diseases. *J Educ Health Promot* 2021;10:19.
  36. Ghadrdoost B, Sadeghipour P, Amin A, Bakhshandeh H, Noohi F, Maleki M, *et al.* Validity and reliability of a virtual education satisfaction questionnaire from the perspective of cardiology residents during the COVID-19 pandemic. *J Educ Health Promot* 2021;10:291.
  37. Hunziker S, Johansson AC, Tschan F, Semmer NK, Rock L, Howell MD, *et al.* Teamwork and leadership in cardiopulmonary resuscitation. *J Am Coll Cardiol* 2011;57:2381-8.