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RESEARCH ARTICLE

Design and Evaluation of Tools for the Psychological Prevention of Injuries in Baseball Pitchers

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Abstract:

Aims:

To determine, through the evaluation of experts, the introduction in the professional practice of tools designed for the psychological prevention of injuries in high-performance baseball pitchers in a Cuban province.

Background:

The psychological interventions for primary injury prevention contribute to the transition from the biomedical to the biopsychosocial approach in sports injury care. However, the studies carried out are very scarce, few generalizable and insufficient to facilitate the multidisciplinary work around the psychological preparation of the athlete as a method of prevention.

Objective:

The objective of this study is to evaluate by experts the design of an Android application and procedure to guide the psychological prevention of injuries in high-performance baseball pitchers.

Methods:

A methodological investigation was carried out to design the tools, which were evaluated by 11 experts who had a professional experience between 14 and 41 years ($M=26.64$; $SD=11.74$). Using the preference method, an ad-hoc questionnaire was applied to obtain the evaluations, being processed by empirical distribution of frequencies, descriptive statistics, Kendall's coefficient of concordance and coefficient of variation.

Results:

The theoretical-methodological foundations of the procedure design, the definition of users, stages and functions, the coherence between tasks, techniques, instruments and means, structure and functionality, and the Android application, were highly valued.

Conclusion:

The designed tools have a high level of adequacy, are pertinent and sufficient to contribute to the psychological prevention of injuries, so they can be introduced into the professional practice of sports psychologists, coaches, and baseball pitchers from Villa Clara. However, its application must be accompanied by a process of experimental research to determine its efficacy, effectiveness, and efficiency.

Keywords: Android application, Baseball pitchers, Sports injury, Psychological prevention, Procedure, Sports psychologists.

Article History

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1. INTRODUCTION

The contemporary development of the sport is characterized by the creation of an increasingly demanding

activity for the human being who practices it, generating complex physical and mental demands. Faced with this reality, the challenge of optimizing athletes' talent is imposed, safeguarding their state of health, for which the process of psychological preparation is essential [1 - 5]. Although the theoretical and instrumental approach to the psychological

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preparation of the athlete has been diverse, in the Cuban context, it is oriented towards the formation of the state of psychic predisposition, the particularities of the personality, the psychological demands of the activity and the pedagogical context in which develops [3].

Several Cuban authors have contributed to the knowledge and improvement of this process, defining among its objectives achieving the maximum level of performance, the optimal or ideal state of performance and the disposition required for success [1, 2, 5]. Through psychological preparation, Cuban psychologists have tried to solve a series of problems such as the regulation of anxiety in competitions, the willingness to perform, the strengthening of self-confidence, the control of psychological responses to training, the reduction of negative psychological effects of injuries, overtraining and burnout [6]. However, from the very conception of psychological preparation, these latest guidelines related to the athlete's health have not been sufficiently explicit, which has led to a lower projection of the preventive dimension of the process [4].

Based on a theoretical systematization carried out by Ríos Garit [4], this author highlights the need to grant a greater theoretical and instrumental scope to the definition of the athlete's psychological preparation, being consistent with theoretical positions that demonstrate the importance of reconciling the approach of performance and health in Sport Psychology [7, 8]. In this connection, the author proposes to broaden the conception of psychological preparation towards the athlete's health care, based on the findings that indicate that this process also contributes to the prevention of inappropriate responses to the physical and mental loads of training and competitions, as well as the appearance of harmful phenomena such as burnout and sports injuries.

Regarding injuries, several researches, have verified the effect of psychological interventions to prevent their occurrence, demonstrating a notable reduction in them [9 - 11]. Despite this, there aren't enough preventive psychological therapies to apply to all activities and environments, making this a crucial and pertinent area of research based on evidence that psychological processes play a part in the development of lesions [12 - 14].

It is essential to highlight that in this field of study, preventive psychological interventions have not been designed to be implemented systematically and systemically in the athlete's preparation process through the participation of multiple actors, nor have they generated technological tools that facilitate decision-making based on updatable evidence. The latter constitutes a current need in injury prevention expressed by Juan [15] when referring to the importance of using computational methods to facilitate the work of sports specialists.

In a consequence of the above and based on recent findings in Cuban baseball pitchers, which show that high anxiety in the competition and low levels of self-confidence, negative coping control and visual-imaginative configure the highest degree of psychological vulnerability to injury [16], procedural and technological tools were designed to integrate injury prevention into the process of psychological preparation of

high-performance baseball pitchers from Villa Clara.

For the design of these tools, the multiple scientific disciplines related to sports injuries and psychological preparation for competitions were taken into account, as well as the actors involved, so that they can be used to prevent injuries through the coordinated action of psychologists, coaches and athletes. This preventive intervention approach contributes to the interdisciplinary work that must be established around the psychological preparation of the athlete as a method for injury prevention. In addition, they make possible the transition from the biomedical to the biopsychosocial approach in preventing sports injuries in baseball pitchers.

The objective of this study is to evaluate by experts the design of an Android application and procedure to guide the psychological prevention of injuries in high-performance baseball pitchers. A favorable evaluation would allow the introduction of these tools in the preparation system of Cuban pitchers in the province of Villa Clara.

2. METHODS

A methodological investigation was carried out [17] for the design of new methods for psychological intervention focused on the prevention of sports injury in high-performance baseball pitchers from Villa Clara. The newly designed tools were subjected to evaluation by experts to determine their pertinence, feasibility, and sufficiency before their introduction into the sports preparation and injury prevention system.

The expert consultation was carried out between October and November 2021. The preference method was used for accuracy, objectivity, and speed [18]. A document was prepared with the rationale, the design of the procedure and the integrated Android application, which was sent to the experts by email or WhatsApp together with the questionnaire to obtain the assessments in each of the aspects of analysis. At all times, feedback was maintained through these channels between the researcher and the experts individually.

2.1. Participants

In order to form a heterogeneous group of experts that would make it possible to provide assessments from different professional profiles and sociocultural contexts, and with a high academic and scientific level, the following selection criteria were established in hierarchical order:

1. The willingness of the potential expert to participate in the investigation.
2. Minimum professional experience of 10 years.
3. Possess a high competence coefficient (K), determined by the formula $K = K_c + K_a/2$, understanding that:

K_c is the knowledge coefficient determined based on the expert's self-assessment, obtained using a scale from zero to ten and multiplied by 0.1, where the zero value indicates absolute ignorance of the problem being evaluated and the value ten indicates full knowledge.

K_a constitutes the argumentation coefficient, obtained by

the sum of the points obtained in each one of the sources of information used to learn about the topic under evaluation.

According to Crespo [19], an expert has a high level of competence when K is established between 0.8 and 1; medium competence between <0.8 and 0.5 and a low level of competence when $K < 0.5$.

4. Possess an academic degree of doctorate or master's degree in sciences related to sport.

5. Possess a current link with the athlete's psychological preparation process or injury prevention.

6. Possess an outstanding scientific and investigative activity related to the study of injuries, the athlete's or baseball pitchers' psychology.

Initially, 20 experts were contacted, of which 15 confirmed their collaboration and issued their assessments. However, 73.3% ($n=11$) were finally selected depending on the individual competence coefficient. Table 1 shows that the selected experts have extensive professional experience, high academic training, and a high level of competence on the subject. In addition, they come from both the applied field and teaching and research in various areas related to the object and field of analysis. All this makes it possible to obtain high-value criteria to decide on the introduction of the tools designed for professional practice.

2.2. Instrument

To obtain the experts' assessment of the relevance and sufficiency of the designed tools, an ad-hoc questionnaire was used. It had 10 items with a Likert evaluation system (1=Very adequate; 2=Quite adequate; 3=Adequate; 4=Partially adequate; 5=Inadequate). The place an item occupies is determined by the number of accumulated points; the higher the total points, the higher the quality of the valued result [18]. In addition, it has an item to obtain a qualitative assessment in case the expert considers it necessary to argue his criteria.

The items were the following:

1. Elaboration of the procedure to contribute to the prevention of injuries through the psychological preparation of the pitcher.

2. Foundation in the determination of a Bayesian network identifying the conditional relationships between psychological variables that configure the risk of injury.

3. Statement of the objective of the procedure.

4. Definition of users.

5. Definition of the stages to reach the systemic fulfillment of the objective.

6. Definition of functions by users.

7. Coherence between tasks, techniques and instruments and means, with respect to each function.

8. Logical design of the functions in stages to fulfill the objective of the procedure.

9. Development of the Android tool based on the Bayesian network to predict the occurrence of the lesion in order to make the application of the procedure viable.

10. Structure and functionality of the application to achieve the fulfillment of its objectives.

2.3. Data Analysis

The evaluations of the experts were analyzed descriptively through empirical distribution of frequencies. Kendall's coefficient of concordance (W) was applied to determine the existence or not of a consensus among the experts, where the value of $W \neq 0$ allows us to reject the hypothesis of casual agreement and affirm that there is a real consensus. To determine specific agreement in each of the questionnaire items, the average and deviation were determined, also calculating the coefficient of variation for each question, whose lower value indicates greater agreement between experts. The SPSS for Windows software package (version 25.0, SPSS Inc.) was used for statistical analyses.

2.4. Ethical Considerations

The research was presented, approved, and endorsed by the Scientific Council and the Medical Ethics Committee of the Provincial Center of Sports Medicine of Villa Clara (number: 0103/2021). The identity of the athletes on whom the findings that support the design of the tools were obtained was always preserved, as well as that of the experts consulted, in such a way that there was no communication between experts. The scores offered on each item of the questionnaire and the qualitative assessments were recorded and processed as is. The investigative procedure and the data treatment strictly follow the ethical precepts in the Declaration of Helsinki.

3. RESULTS

3.1. Procedure Design

The design of the procedure and the Android application was based on a Bayesian network (BN) obtained to estimate the psychological risk of injury in high-performance baseball pitchers from Villa Clara, whose predictive capacity was duly verified through previous research [16, 20].

The objective of the procedure: Contribute to the prevention of injuries through the psychological preparation of high-performance baseball pitchers.

3.1.1. Users

Sports psychologists, coaches, and baseball pitchers when recognizing their active and leading role in their own preparation, considering the stage of psychological development and their sports experience.

3.1.2. Stages

1. Start-up: it consists of the introduction of the process in practice and is made up of the diagnostic sub-process. This constitutes the fundamental step to guarantee the validity of the predictions.

2. Application: this consists of estimating the probability of occurrence of the injury for each pitcher, propagating evidence in the Bayesian network in Android support based on obtaining diagnostic data, as well as the execution of preventive actions.

It is made up of the sub-processes of probabilistic estimation and intervention.

3. Evaluation: consists of the contrast between the probability of injury estimated a priori, the action executed and the occurrence of the injury. The designed application facilitates this process.

4. Maintenance and updating: consists of introducing new information into the database to promote learning of the Bayesian network by updating the psychological predictors and their conditional relationships.

Fig. (1) shows the stages of the procedure and their relationships.

Table 2 shows the functions to be performed during each stage, the tasks with their techniques and instruments, and the necessary resources depending on the professionals involved in the psychological prevention of injuries.

Table 3 shows the recommendations for the sports coach to carry out preventive actions during potentially stressful situations during the games.

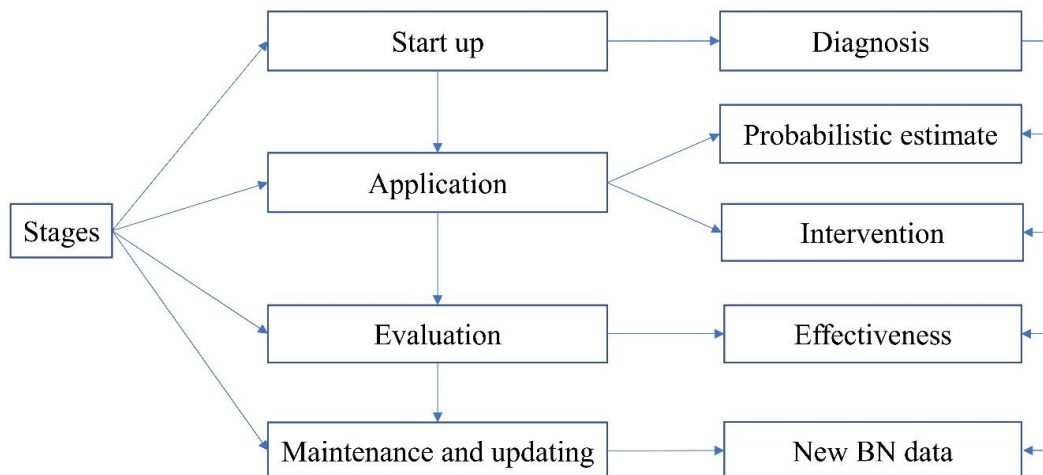


Fig. (1). Stages of the procedure.

Table 1. Description of the characteristics of the experts.

No.	EP	K	Country	Degree	Professional Area	Field of Expertise	
1	17	0.95	Spain	PhD	Professor and researcher	Psychology and sports injuries	
2	21	0.88	Spain	PhD	Professor and researcher	Injury prevention	
3	41	0.90	Mexico	PhD	Applied psychologist	Psychology in baseball	
4	47	0.88	Cuba	PhD	Professor and researcher	Psychological preparation	
5	34	0.80	Cuba	PhD	Professor and researcher	Psychological preparation	
6	14	0.85	Cuba	PhD	Applied psychologist	Psychological preparation	
7	40	0.90	Cuba	PhD	Professor and researcher	Biomechanics and sports training	
8	16	0.80	Cuba	Master	Professor and researcher	Psychology in baseball	
9	21	0.80	Cuba	Master	Applied psychologist	Psychological preparation	
10	17	0.80	Cuba	Master	Applied psychologist	Psychological preparation	
11	25	0.85	Cuba	Master	Applied psychologist	Psychological preparation	
Statistical				Min	Max	M	SD
Professional experience				14	47	26.64	11.74
Level of competition				0.80	0.95	0.85	0.05

Note: PE=Professional experience; Min= Minimum; Max= Maximum; M= mean; SD= Standard deviation; K= 0.8-1= High competence; 0.5-0.8 Medium level of competence; < 0.5= Low level of competence.

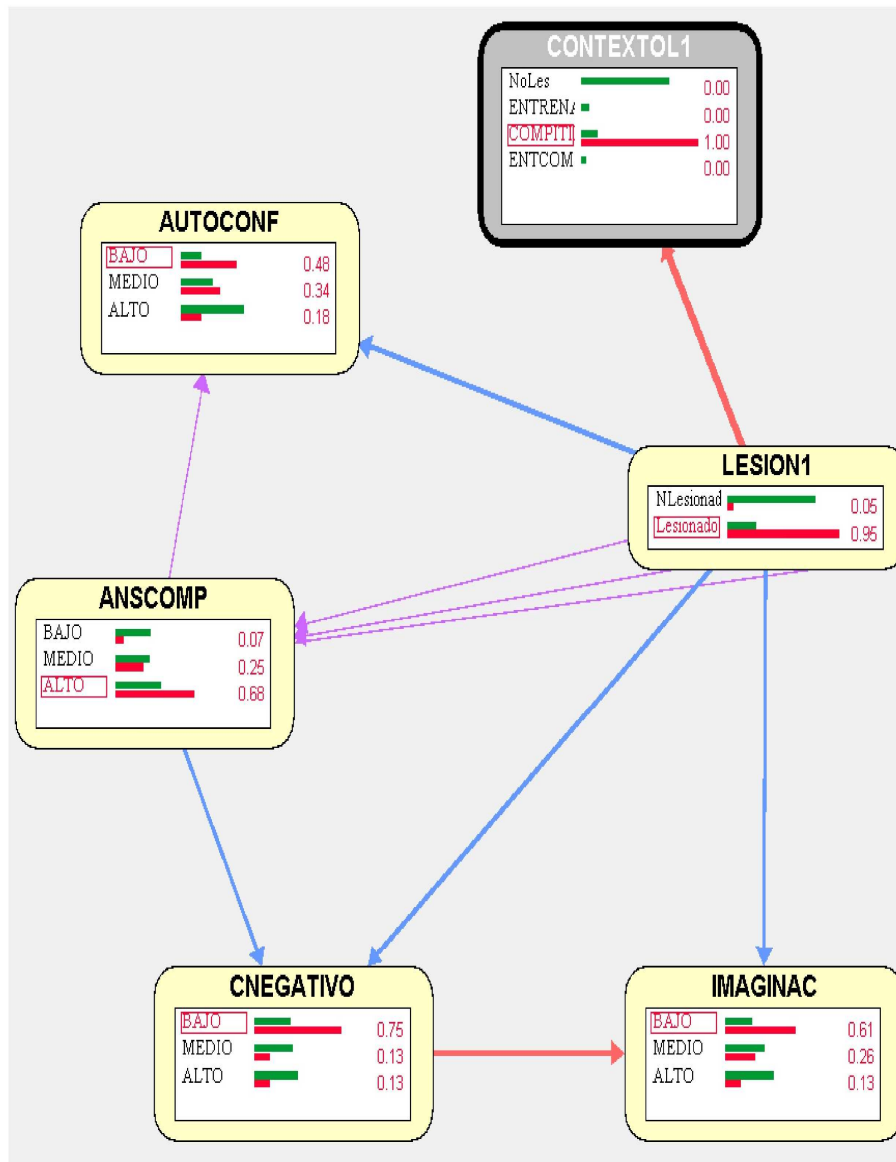


Fig. (2). Bayesian network for the psychological prediction of injury in baseball pitchers from Garit *et al.* [16].

3.2. Android App Design

For the design of the Android application, the Visual Studio Code v1.63.2 software was used, and its mode of operation constitutes the real-time simulation of the Bayesian network that supports it, which is represented in Fig. (2).

3.2.1. Objectives

1. Determine the probability of injury for each pitcher based on their psychological characteristics.
2. Guide preventive decision-making regarding the use of pitchers based on the psychological characteristics that configure the risk of injury.
3. Evaluate the effectiveness and efficiency of the predictive model and the preventive actions designed.

3.2.2. User

Sport Coach

3.2.2.1. Operation Mode

1. When starting the application, the athletes must first be registered to enter the data obtained in the psychodiagnosis on the predictive psychological variables determined by the Bayesian network and the context in which the pitcher is (training or competing).
2. Other data should be added regarding the date and place where the training or competition takes place.
3. In the case of the competitive game, the current situation of the match (winning or losing) must be added, as well as the inning in which the potentially stressful situation is established.

4. Based on the estimated probability of injury given the characteristics of the predictor variables, a recommendation for the sport coach is established, which may or may not be accepted.

5. Record whether the injury occurred at the time the potentially stressful situation occurred or as a result of it.

6. Finally, the data is recorded, facilitating its subsequent consultation and the evaluation of the prediction and preventive actions.

The application not only allows estimating the probability of injury in each pitcher, but it guides preventive actions based

on the level of risk and records each time it is used, facilitating the evaluation process. Fig. (3) shows how the application works by introducing the extreme negative values of the psychological variables that predict injuries in the analyzed pitchers.

3.3. Expert Assessment

Fig. (4) shows the scores achieved in each item of the questionnaire, showing that most of the items are valued between very adequate and adequate. However, it is observed that two experts value the definition of users inadequately.

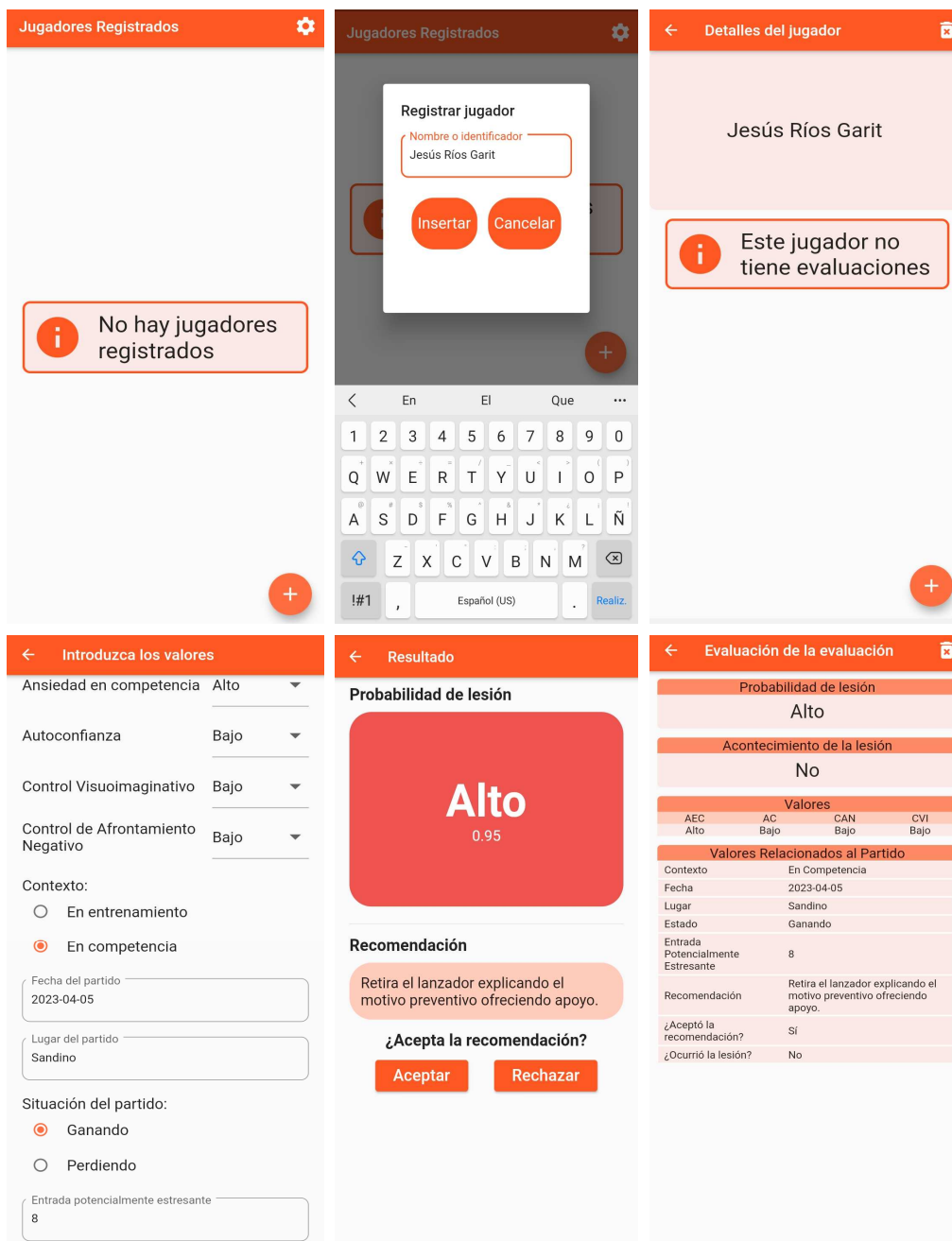


Fig. (3). Design and operation of the application based on the Bayesian network obtained.

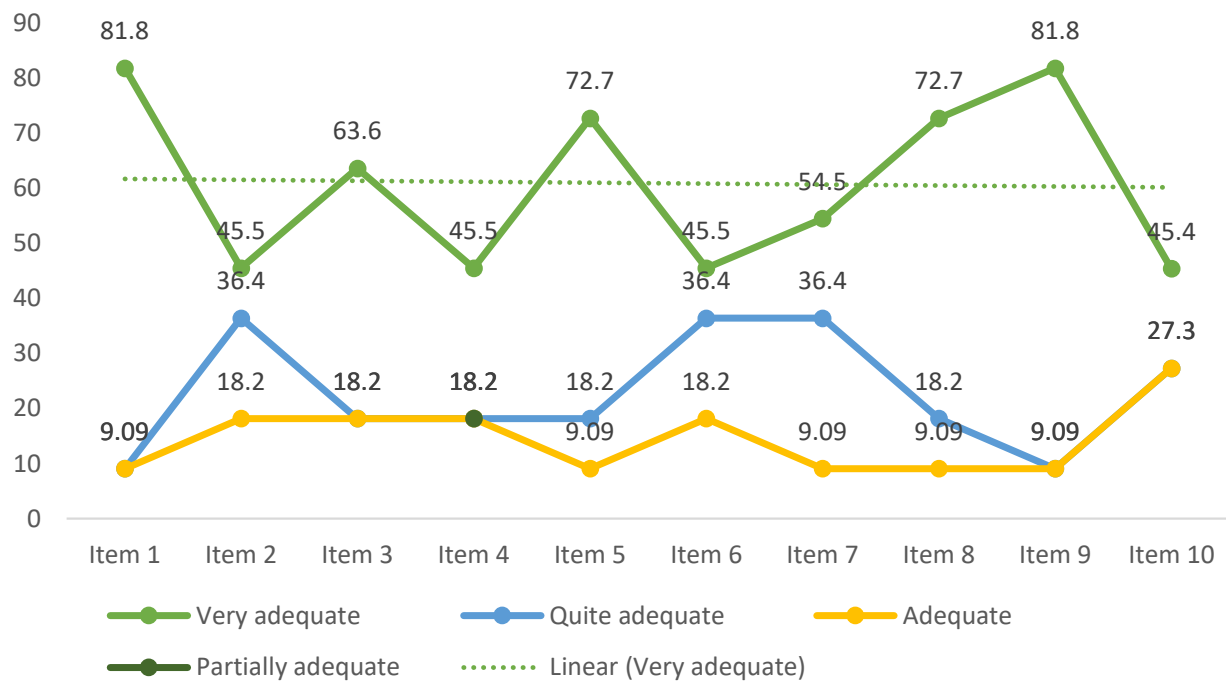


Fig. (4). Distribution of the evaluations of the experts before each question of the questionnaire.

Table 2. Distribution of functions, tasks, techniques and instruments and means.

User	Functions	Stage	Tasks	Techniques and Instruments	Resources
Psychologist	Determine the psychological performance profile of each pitcher by diagnosing anxiety and psychological skills.	Start-up	Psychodiagnosis	IDARE CSAI-2 IPED	Laptop Tests
			Elaborate file individual psychological pitcher.		
			Report and discuss the results.		
Stimulates potentialities and minimizes psychological weaknesses.	Application	Psychological preparation	Cognitive behavioral stress training. Mindfulness Positive self-talk Set up social support in the team. Visualization of potentially stressful situations. Motor imagery.		
Update the Bayesian network	Maintenance and update	Introduce new data on psychological diagnosis and injuries in BN	Modeling	Laptop	
Coach	Spread evidence in the Bayesian network from the diagnostic results.	Application	Estimate the probability of occurrence of the injury in each pitcher	App	Android device
	Stimulates psychological adaptation to potentially stressful game situations.	Application	Psychological preparation	Modeling competitive	Game situations simulated
	Make decisions regarding the use of pitchers based on the psychological characteristics that configure the risk of injury.	Application	Intervene in the pitcher's work depending on the risk of injury in game situations that generate psychological tension.	App	Android device
	Participate in the adaptation process of the pitchers' partial self-assessment of performance.	Application	Promote self-evaluation, peer-evaluation, and hetero-evaluation of pitchers' performance through assertive communication.	Discussion group	
	Evaluates the contribution of psychological prediction to injury prevention.	Evaluation	Analyze the relationship between the probability, the action taken and the occurrence of injury in each case.	App	Android device

(Table 2) contd.....

User	Functions	Stage	Tasks	Techniques and Instruments	Resources
Pitcher	Appropriately deal with negative emotions during games.	Application	Establish a brief relaxation ritual in situations of tension.	Diaphragmatic breathing Muscle relaxation Mindfulness	

Note: IDARE= Trait-State Anxiety Inventory; CSAI-2= State Anxiety Inventory in Competence; IPED= Psychological Inventory of Sports Execution; APP = Android Application; BN= Bayesian Network.

Table 3. Preventive actions depending on the probability of injury in potentially stressful situations.

Probability Estimated	Risk of Injury	Action Preventative
0.49-0.95	High	Remove the pitcher explaining the preemptive reason by offering support.
0.33-0.48	Medium	Visit the box to guide the tactical plan considering the current situation and reconfigure the perception of the situation as a challenge and not a threat. To do this, he requests the presence of the infielders showing support, security, and confidence.
0.01-0.32	Low	Visit the box to boost the pitcher's self-confidence by reconfiguring the perception of the situation as a challenge and not a threat.

Table 4 shows the results of the concordance coefficient to determine whether there is a consensus between the assessments made by the experts consulted. The concordance coefficient indicates that there is a consensus in the experts' assessments, therefore, the hypothesis of casual agreement is rejected. This result indicates that the positive evaluations of the experts are not established randomly but are based on the scientific and technological quality of the design of the tools.

Table 5 shows the analysis results of the level of agreement between the experts in each of the items of the applied questionnaire. Both the deviation and the coefficient of variation in the answers given to each item are low, so the specific concordance of the evaluation criteria of the experts is

assumed.

4. DISCUSSION

In psychological interventions to reduce the risk of injury, several authors have decided to apply actions related to stress management based on the Stress and Injury model [21], among which is the application of cognitive therapy, behavioral therapy for stress management [22], stress management, relaxation, emotional control, and goal-setting skills [23] and stress inoculation therapy [24]. Despite their notable results, these intervention programs have not been systematically and systemically integrated into the process of psychological preparation or injury prevention, placing full responsibility for the process on the psychologist.

Table 4. Evaluation of the level of general agreement between the experts.

Questionnaire Items	Average Ranges	Kendall W	p.
1	4.15	0.169	0.084
2	6.00		
3	5.60		
4	6.60		
5	5.10		
6	6.10		
7	5.60		
8	5.10		
9	4.15		
10	6.60		

Note: W≠0.00 (Non-random agreement)

Table 5. Evaluation of the level of agreement in each item of the questionnaire.

Statistical	Questionnaire Items									
	1	2	3	4	5	6	7	8	9	10
Mean	1.20	1.70	1.60	2.10	1.40	1.70	1.50	1.40	1.30	1.90
SD	0.63	0.82	0.84	1.28	0.69	0.83	0.70	0.69	0.67	0.87
Cfv	0.11	0.12	0.21	0.13	0.22	0.21	0.21	0.21	0.11	0.21

Note: SD= Standard deviation; Cfv= Coefficient of variation

With the multidimensional perspective of the preventive work of the injury and the psychological preparation of the athlete [2,25], the active participation of the coach, the baseball pitchers themselves and the sports psychologist was designed. The preventive actions to be carried out by the coach during games in potentially stressful situations are also based on the estimated probability of injury for each pitcher based on his predictive psychological characteristics. The ranges were established from the determination of the highest (0.95) and lowest (0.01) degree of probability possible according to the Bayesian network that is the basis for the design of the tools [16].

Preventive actions designed based on the degree of vulnerability allow guiding decision-making in risk situations, which are considered potentially stressful because they can exceed the coping resources of the thrower, being able to trigger negative emotional states and affect their performance by generating psychic tension during matches. These situations are diverse depending on the perception of the pitchers [26], but they have as a common feature the threat of the opponent to score runs [27]. Likewise, the Android application developed is integrated into the procedure as technological support to enable the introduction of the result to professional practice, becoming a tool needed by psychologists and coaches, as referred to by Juan [15].

It was possible to form a heterogeneous sample of experts in terms of the practice of the profession, including teaching, research and applied area functions, as well as the field of expertise in relation to injuries, psychological preparation, and sport-specific sports training for which the procedure was developed. These characteristics make it possible to obtain a general assessment of the procedure from different relevant angles for its introduction into professional practice.

The results allow us to affirm that the designed tools have been valued favorably by the experts, since the mean of the questionnaire items was always found between the ranges corresponding to the maximum possible evaluations to be obtained (very adequate and quite adequate, respectively). However, it was also obtained that two experts agree that the functions designed for the sports coach are part of the specialized work of the sports psychologist and they value the inclusion of this professional in the process of psychological prevention of injuries in an inadequate way, not coinciding with the rest of the experts. Despite this, these negative evaluations did not modify the favorable evaluation of the item.

Even though the tools have been assessed as pertinent and sufficient, it should be noted that they should only be applied with high-performance baseball pitchers from Villa Clara, since their design is based on exclusive findings in this sports population. This limitation can be overcome with future research, increasing the number of analyzed pitchers who participate in the Cuban baseball series, which would allow standardizing and validating the use of the tools at the national level or updating them in case different findings are obtained.

Before being able to apply these tools to another team in the Cuban national series, the effectiveness of the Bayesian network must be verified to predict injuries in all, or at least in

most of the teams. This procedure must be conceived within the framework of an experimental research process to verify its efficacy, efficiency, and effectiveness, controlling variables intervening or unrelated to psychological preparation that may influence the occurrence of injuries.

CONCLUSION

According to the experts consulted, the designed tools are ideal for their introduction into the professional practice of sports psychologists, high-performance baseball sports coaches and pitchers from Villa Clara since they can be applied in the context of psychological preparation for the competitions. However, the authors consider that due to its novelty and complexity, the users involved in its execution, maintenance, and evaluation should be trained before its implementation.

AUTHORS' CONTRIBUTIONS

JRG: Conceptualization; Research; Methodology; Data curation; Formal analysis; Project administration; Writing - original draft; Writing - review & editing.

YPS: Conceptualization; Research; Methodology; Data curation; Formal analysis; Writing - original draft; Supervision.

SSC: Research; Methodology; Formal analysis; Writing - original draft.

CMR: Formal analysis; Writing - original draft.

ABRR: Software; Writing - original draft.

MCCC: Software; Writing - original draft.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study is part of the research project: "Psychological Preparation and Sports Injuries in Team Sports", approved and endorsed by the Scientific Council and the Medical Ethics Committee (number: 0103/2021) of the Provincial Center of Sports Medicine of Villa Clara, Cuba.

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All research procedures involving humans were performed in accordance with the Helsinki Declaration.

CONSENT FOR PUBLICATION

The athletes participated voluntarily, giving their informed consent.

AVAILABILITY OF DATA AND MATERIALS

The data used in this study are available upon request from the corresponding author [J.R.G].

STANDARDS OF REPORTING

COREQ guidelines were followed in this study.

FUNDING

None.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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Declared none.

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