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Considering the Validity and Reliability Testing of a Digital Punch Measuring Tool in Young Combat Athletes

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Abstract

Objectives. The application of technology in sports, including combat sports, is increasing rapidly. This study aimed to determine the validity and reliability of digital punch-measuring tools in young combat athletes.

Materials and methods. A total of 28 participants, consisting of 9 males (age 15.88 ± 1.6 years, height 162.56 ± 6.8 cm, weight 55.2 ± 10.2 kg, BMI 20.7 ± 2.5, PBF 14.57 ± 4.5 %) and 19 females (age 14.5 ± 1.5 years, height 154.3 ± 5.4 cm, weight 48.6 ± 8.5 kg, BMI 20.4 ± 3.2, PBF 27.4 ± 6.5 %) from the martial arts branch involved in the study and were included in data collection. The method used in this study was the Pearson Product-Moment Correlation Coefficient, analyzed using Minitab version 21. All research subjects engaged in a warm-up routine before performing three punches with both their right and left arms.

Results. The findings of this study indicate positive validity (right 0.856, left 0.875) and reliability (right 0.8037, left 0.8209) in measuring both right and left punches.

Conclusions. Thus, digital punch measuring tools can be used for training to improve punches and as an initial test tool for implementing effective training programs and monitoring the development of combat athletes.

Keywords: digital punch measuring tools, martial arts sports, young athletes.

Introduction

Martial arts is a popular sport in various countries (Bishop et al., 2013; Rydzik et al., 2024; Vertonghen & Theeboom, 2010). This sport requires good aerobic and anaerobic abilities, especially for the explosive power and strength components (Chaabène et al., 2015). This is related to the athlete's explosive movement ability when kicking and punching an opponent (Walilko et al., 2005). For example, in the sport of boxing, where quality punching movements are the main movement that determines victory during a fight (Chaabène et al., 2015). According to (Lenetsky et al., 2013) the ability to produce high levels of muscle strength is the key to success in punching movements, especially in professional boxing. Apart from that, many previous studies also explain that the strength of the blow is a determining factor in the outcomes of the fight (Bianco et al., 2013).

Unfortunately, specific measurements of punch strength in youth martial arts sports are still limited. Young athletes themselves are still not at their peak in terms of ability, so their developmental characteristics are important to measure and monitor (Difiori et al., 2014). Monitoring the number of hours of exercise and the movement techniques used may play a role in reducing the risk of injury (Demorest et al., 2016). Meanwhile, due to limited costs and facilities, most punch strength is only measured conventionally using similar movement methods, such as push-ups and bench presses. However, it is felt that this is still unable to describe specific muscle groups and movements in martial arts, considering that the muscle involvement when hitting is more complex.

It is proven from research findings (Lopez-Laval et al., 2020) that several variables are not related between bench press ability and rear arm punch speed. There needs to be a tool that can be measured digitally to optimize it.

For several decades there have been tools used to measure punch strength, including heavy bags, force plates, strain gauge-based measurement systems, and accelerometers (Falco et al., 2009; Pędzich et al., 2006). However, each of these tools still has several shortcomings to be implemented, ranging from cost, operation, and data collection to the methods used. For example, research conducted (Lopez-Laval et al., 2020) to measure punching performance only used punch speed as an indicator, while the force generated from the punch has not yet been assessed. In another study, force measurements were carried out using modified force plates that was attached to the wall with a body protector coated on the outside to minimize hard impacts that could cause injury to athletes (Loturco, 2016). However, this method is only limited to certain punching movements such as jab and straight, while the types of punches involved in combat sports vary greatly. Apart from that, the target designed for this tool is still limited to one point, while we know that in martial arts sports, the target of the blow is on the opponent's body in more than one place and requires precise and fast timing to deliver the blow based on the opportunities obtained during the fight.

To overcome some of these obstacles, we are developing a tool for measuring punch strength in martial arts athletes called Sansak Digital or Sandit (Surabaya State University, Surabaya, Indonesia). This tool uses the same measurement method as (Del Vecchio et al., 2022), where there are plates, foam, and pressure sensors using a load cell, which is integrated with software on a laptop via a USB cable connection. Even though the Sandit does not have an accelerometer, this tool has the advantage of having 4 hitting target points that depict the opponent's body segments and is equipped with reaction action indicator lights so that it can specifically train athletes' martial arts punching techniques and reaction speed simultaneously. Considering the importance of validity and reliability of a tool (Aragon-Vargas, 2000; Firmansyah et al., 2024). Currently, the weakness of Sandit is that there is no tool reliability testing that can strengthen the reasons for using this tool in the training process and testing.

Therefore, this study aims to test the validity and reliability of digital sansak on young athletes in martial arts sports. If this tool is proven to have a good level of reliability, it can be a solution to some of the problems experienced by previous test tools.

Material and Method

Participant

A total of 28 people with composition, 9 men (age 15.88 ± 1.6, height 162.56 ± 6.8, weight 55.2 ± 10.2, BMI 20.7 ± 2.5, PBF 14.57 ± 4.5) and 19 women (age 14.5 ± 1.5, height body 154.3 ± 5.4, weight 48.6 ± 8.5, BMI 20.4 ± 3.2, PBF 27.4 ± 6.5) from the martial arts branch participated in data collection. The method in this research uses the Pearson Product validity and reliability test with Minitab software version 21. The inclusion criteria for this research are the number of years of experience. Had no history of injury to either the upper or lower extremities during the study (Ambroży et al., 2022) tactics, and movement structure, and requires an adequate level of motor skills as a foundation for activities during competitions. General physical fitness, defined as the effect of the externalization of motor skills, is the basis for athletic training regardless of the sport. The aim of this study was to determine the effect of modified training based on the principles of CrossFit on the development of general physical fitness in a group of kickboxers compared to a control group. Methods: The study was experimental in nature and was conducted in a group of 60 kickboxers, divided into experimental and control groups. Participants were selected by purposive sampling, and the criteria were training experience, sports skill level (minimum class 1 athletes. This research has received ethical permission from Number: 795/KEP. 01/UNISA-BANDUNG/V/2024, referring to the Declaration of Helsinki.

Procedure

Before data collection, all athletes filled out informed consent, a sports injury screening using modified questions from (Fuller et al., 2006). Next, they tested height using Metrisis (Surakarta, Indonesia) and body composition using InBody 270 (Seoul, South Korea). After that, they were asked to warm up for 30 minutes and hit the digital punch three times each on the right and left arm in succession. Each person who makes a punch has their strength calculated on a tool with a load cell system installed behind the pad on the Sandit and recorded automatically in the internal software. The force applied to the plate or pad is then sent via a USB cable connected to a laptop into Newton's (N) data.

Statistical Analysis

This research uses the Pearson correlation validity and reliability test. After all the data has been collected, it goes to the analysis stage using Minitab version 21 (Pennsylvania, USA) with the Anderson-Darling normality test method to determine the overall data distribution. The Pearson Correlation Product was chosen because the data obtained was normally distributed and then entered the validity testing stage with a CI of 95 % and an r-table value = 0.37 from a total of 28 subjects. This validity testing method is the same as that used in previous studies (Deiss et al., 2024; Sahu et al., 2024) in clinics without an IKD, clinicians default to using handheld dynamometers (HHD). Referring to (Ferreira et al., 2021) which can provide valid information to implement effective treatment and exercise training. The purpose of the study was to examine the instrumental validity of the hanging scale (HS research, the reliability test in this study uses Cronbach's Alpha with a value of > 0.7, so the reliability test can be fulfilled). Testing of the validity and reliability of punch strength was carried out on each side, both the left and right arms. Data is presented in the form of means and standard deviation.

Results

Below is a table containing the characteristics of the subjects who participated in this research:

Table 1. Characteristic of Participant

	Age (years)	Weight (kg)	Height (cm)	BMI	PBF (%)
Male	15.88 ± 1.69	55.20 ± 10.11	162.56 ± 6.84	20.74 ± 2.50	14.57 ± 4.52
Female	14.57 ± 4.57	48.66 ± 8.53	154.37 ± 5.46	20.41 ± 3.28	27.40 ± 6.54

Notes: BMI = Body Mass Index, PBF = Percent Body Fats

Validity Results

The results of this study show that all r-values exceed the r-table value with a total of 28 subjects (0.37). It can be seen from table 1 where the right punch value after statistical testing uses Pearson's to test the level of validity of the digital sansak with r-values in sequence Trial 1 (0.83), Trial 2 (0.88), and Trial 3 (0.85). Meanwhile, the results of the left blow can also be seen from Trial 1 (0.82), Trial 2 (0.91), and Trial 3 (0.87).

Table 2. Validity Test Pearson's

Validity of	r-value Trial 1	r-value Trial 2	r-value Trial 3	r = table (n = 28)
Right Punch	0.83	0.88	0.85	0.37
Left Punch	0.82	0.91	0.87	0.37

Reliability Results

In the reliability test results, researchers used Cronbach's Alpha test to find out the level of consistency of the digital punch when used to measure the strength of the blow over three trials. As we can see in Table 4 the results of Cronbach's Alpha test show that the value for the right hit is 0.80, while for the left hit the value is 0.82.

Table 3. Punch Strength / Trial

	Trial 1	Trial 2	Trial 3
Right Punch (N)	66.49 ± 33.16	85.25 ± 41.12	84.43 ± 49.73
Left Punch (N)	61.74 ± 32.24	88.70 ± 48.33	78.64 ± 53.69

Notes: (N) = Newton

Table 4. Reliability Test Cronbach's Alpha

Reliability of	n	CA
Right Punch	28	0.80
Left Punch	28	0.82

Notes: n = all participants, CA = Cronbach's Alpha Value (> 0.7)

Discussion

This research aims to test the validity and reliability of digital sansak. Like most previous research (Mondin et al., 2018; Menzel & Potthast, 2021) tests how reliable a tool is before applying it to sports training. This technology is designed to help coaches monitor and measure how strong the blows produced by their athletes. Digital-based measurements minimize inaccurate decision-making processes because assessments are carried out objectively, not subjectively. In addition, accurate and variable measurement data is important for monitoring training progress and results (Lambert et al., 2018). In this test, the validity test results (Table 2) were obtained, both (left and right arms) were valid (r-value > r-table, n = 28), meaning that this tool could be trusted and used in the next trial with a larger number of subjects. In research conducted by (Soga et al., 2023), the small number of subjects could influence the results of the statistical analysis carried out.

The use of technology in the training process needs to be developed so that it can monitor the training process objectively to make the data collection process easier. For example, the use of the global positioning system (GPS) to monitor the physical demands during soccer training on the field (Santos et al., 2024), measuring hamstring muscle strength to determine appropriate and measurable training programs for handball athletes (Firmansyah et al., 2024) weight 62.6 ± 20.7 kg, height 173.6 ± 5.0 cm, BMI 22.1 ± 4.0 kg/m^2, Sprinters (Yeung et al., 2009), American Football (Feeley et al., 2008), and other competitive sports with a predominance of high-intensity sprint movements. It is also important to monitor heart rate periodically to determine the appropriate training zone (Sylta et al., 2014) 13 female; 25 ± 4 y; 70 ± 11 kg; 76 ± 7 mL · min^{-1} · kg^{-1} VO_2max.

Young martial arts athletes need to measure arm muscle strength as material for coach evaluation. Speed is not enough, increasing punching power is the goal of training in combat sports (Dunn et al., 2022). Because punching power is an important factor in combat sports (Lambert et al., 2018). The number of punching movements may influence the amount of force produced so that the force exerted will vary each time. The digital sansak was proven to have a high level of reliability, where after carrying out a reliability test for three attempts at hitting the results were very good (Cronbach's Alpha > 0.07) (Table 4). Therefore, digital punching can be recommended for repeated measurement of punch strength.

Limitations in this research include the relatively small number of subjects tested. Then the second limitation is that there is no other tool that can be categorized as the gold standard for measuring punch strength as a comparison to the results obtained from digital sansak. Future research is recommended to use a larger number of subjects with various ages, genders, and punch variations. Then using a tool that has a gold standard can show how big the margin is between Sandit and that tool.

Conclusions

This research concludes that the digital sansak is a valid and reliable tool for measuring punching strength. So, it can help in the martial arts training process to assess how strong a blow can be produced. This technology can also be used to assess blows repeatedly, even though the number of subjects used is still small.

Conflict of interest

The authors declare that there is no conflict of interest.

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Перевірка валідності та надійності використання цифрового інструменту для вимірювання сили удару кулаком у юних спортсменів-єдиноборців

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 6 с., 4 табл., 30 джерел.

Мета дослідження. Застосування технологій у спорті, зокрема у спортивних єдиноборствах, стрімко зростає. Мета цього дослідження полягала у визначенні валідності та надійності використання цифрових інструментів для вимірювання сили удару кулаком у юних спортсменів-єдиноборців.

Матеріали та методи. У дослідженні взяли участь загалом 28 осіб: 9 – чоловічої статі (вік 15,88 ± 1,6 року, зріст 162,56 ± 6,8 см, вага 55,2 ± 10,2 кг, ІМТ 20,7 ± 2,5, відсоток жирової маси тіла 14,57 ± 4,5%) та 19 – жіночої статі (вік 14,5 ± 1,5 років, зріст 154,3 ± 5,4 см, вага 48,6 ± 8,5 кг, ІМТ 20,4 ± 3,2, відсоток жирової маси тіла 27,4 ± 6,5 %), які займаються бойовими мистецтвами та були включені до збору даних. Для аналізу результатів дослідження було застосовано коефіцієнт кореляції моменту добутку Пірсона ("Pearson Product-Moment Correlation") за допомогою програми Minitab версії 21. Усі досліджувані займалися розминкою перед виконанням трьох ударів кулаком правою та лівою рукою.

Результати. Результати цього дослідження свідчать про позитивні показники валідності (правий 0,856, лівий 0,875) і надійності (правий 0,8037, лівий 0,8209) у процесі вимірювання сили удару кулаком як правою, так і лівою рукою.

Висновки. Таким чином, цифрові інструменти для вимірювання сили удару кулаком можна використовувати для тренувань з метою вдосконалення таких ударів, а також як початковий інструмент тестування задля впровадження ефективних тренувальних програм та моніторингу розвитку спортсменів-єдиноборців.

Ключові слова: цифрові інструменти для вимірювання сили удару кулаком, бойові мистецтва, юні спортсмени.

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