

Fitness level and the relationship between heart rate, body water, dehydration symptoms in adolescents during a pandemic

By Rizki Mulyawan

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Abstract

This study was conducted to find out the body response occurred immediately after bleep test 5ter undergoing a pandemic period of more than one year. This research is an analytic observational study with a cross sectional approach, using purposive sampling technique, the research subjects were 43 students, 14 women and 29 men with the criteria (1) sports students who were physically active three times a week during last 1-2 months; (2) no injury or (3) illness in the last 3-7 days. The instruments used are polar heart rate monitor h-10 (measure heart rate), Omron HBF 375 Karada Scan (assess percentage of water in the body) and urine color scale (dehydration predictor). Data analysis through homogeneity test, Kormogorov-Smimov normality test and Pearson Correlation test. Findings of this research were female (30.2 ± 2.63) and male (36.8 ± 5.31) VO_2 Max concluded as fair category. There was no significant relationship between heart rate with body water ($0.071 > 0.05$) and urine color ($0.557 > 0.05$), even body water and urine colour ($0.10 > 0.05$). The pandemic period is proven to make fitness levels stand on fair category. Heart rate, body water percentage and dehydration do not have a significant relationship each other.

Keywords: heart rate, body water, dehydration, Bleep test, fitness

INTRODUCTION

During the pandemic, almost everyone experiences limitations in movement except for the essential sector in the health sector. Most people stay at home without any activities. All forms of communication have suddenly turned online, including in education, notably higher education (Abidah et al., 2020; Besser et al., 2020; Xhelili et al., 2021). This new habit will undoubtedly change the lifestyle of each individual. Prolonged time in front of the screen becomes a routine and repetitive behavior every day. In addition, it is feared that there will be problems with *sedentary behavior* (Dunstan et al., 2012; Inyang, 2015), especially at risk of attacking young children. There needs to be the best solution, such as getting used to doing sports or exercises to increase body immunity (Constandt et al., 2020).

The long-sitting time due to online learning clearly has a negative impact (Y Chau et al., 2016). One of them is on student fitness. Student fitness will tend to decrease along with a decrease in exercise habits due to the new normal changing lifestyle. Therefore, measuring the maximum lung capacity is necessary to observe the extent of the development or decline in student fitness conditions during the pandemic. The purpose of a fitness

test is to raise awareness of several aspects of fitness related to health that will experience an acute response that is different from the previous fitness condition. This identification is helpful for students to understand their body conditions, including heart rate, body water percentage, and dehydration when doing sports with maximum intensity.

The heart rate is related to body adaptation to the exercise intensity, the higher the intensity, the higher the heart rate (Johnson et al., 2017; Levine & Buono, 2019). Meanwhile, body water percentage will relate to how a person has a balanced fluid intake during the pandemic. As all we know, eight glass of water should be fulfilled on a day (Kemenkes RI, 2020), if someone had insufficient hydration will experience performance drop (Owen et al., 2013) and dehydration (Kenefick & Cheuvront, 2012). While, adolescent often skip beverage intake (Mata et al., 2021). Ultimately, after carrying out a fitness test, it will discover whether a person is experiencing a lack of fluids from maximum exercise (Bibiloni et al., 2018; Kuecher et al., 2017; Perrier, 2017), due to the body's maximum work and lack of time to get fluid intake during the test. This study is crucial considering that most of the adolescents or young adults only active at home during the pandemic, if linked with basic theory, there will be tendency to reduce physiological responses toward maximum intensity exercise if there is applied lower in duration, frequency or variation of exercise, therefore adaptation is needed (Kenney et al., 2015). The purpose of maximum intensity exercise based on a need for continuous fitness monitoring to prevent accumulation of derivation physical ability.

So far, most studies only discussed about how the pandemic has led to changes in body functions such as reduced body work efficiency and recovery after exercise (Mozolev et al., 2021). One of longitudinal studies discussing the effects of the pandemic on physical activity patterns tracked by using BetterPoints Smartphone explained a significant change in physical activity was found between a week before the first case of COVID-19 was published (as initial data) to the week when activity restrictions were removed (McCarthy et al., 2021). In addition, there are studies that only

explain how the pandemic affects physical activity levels (M. Brown et al., 2021; Zenic et al., 2020). The last study found about fitness level on professional football athlete (Rampinini et al., 2021). However, there are still a few interesting studies has been discussed about how the effect of implementing new normal habits during pandemic on students fitness condition accompanied by acute response on heart rate, body water and urine colour as indicators of dehydration.

Therefore, this study investigated heart rate, body water percentage, and dehydration as an acute response post-fitness test (bleep test) on college students during a pandemic. The study results are expected to reveal sports students fitness during the pandemic and the relationship between heart rate, body water percentage, and dehydration as an acute response to the fitness test. The study aimed to raise awareness that people taking a fitness test, especially a field test, can understand the possible risks and be experienced by the subjects after doing the bleep test, primarily with the decline in fitness conditions due to the pandemic.

METHOD

This study was an analytical observational conducted with a cross-sectional approach, emphasizing the observation of data at one time carried out on the dependent and independent variables. An analytical observational study is carried out by making observations without treatment from the researcher (Ary et al., 2010; Creswell & Creswell, 2018).

Study subjects were collected using *purposive sampling* (Creswell & Creswell, 2018), where subjects were selected following predetermined criteria, i.e., the age of late adolescence (Wahyuni, A., 2016) or young adults (Damasceno et al., 2018) between 18-21 years old with inclusion criteria (1) being active in exercising three times a week; (2) have not been injured or (3) being sick in the last 3-7 days. The number of subjects involved in this study was 43 people. Pandemic makes data collecting protocol restricted considering health protocol and not done at once, so that it is arranged to be divided into four data retrieval terms.

Bleep test categories were grouped based on a scale of *very poor* (< 33.0), *poor* (33.0-36.4), *fair* (36.5-42.4), *good* (42.5-46.4), *excellent* (46.5-52.4) dan *superior* (>52.4). Whereas, for female, *very poor* (< 23.6), *poor* (23.6-28.9), *fair* (29.0-32.9), *good* (33.0-36.9), *excellent* (37.0-41.0) dan *superior* (>41.0) (Ariestika & Nanda, 2020). Another instrument used to determine the heart rate was the polar heart rate monitor h-10, then identifying body water percentage using the Omron HBF 375 Karada Scan. Then, the measurement of dehydration through urine sampling, using visible observation assisted by a urine color scale guide that has been prepared in the toilet as control sign and supervision from tester outside the toilet to recheck the urine scale, the range of 8 urine color scales is used an eight-urine color scale: the hydrated category (scale 1, routine white color; scale 2, slightly yellow saturation white; scale 3, a mix of white and yellow), dehydration category (scale 4, majority yellow, slightly white; scale 5, yellow; scale 6, concentrated yellow), and severe dehydration (scale 7, brownish-yellow color; scale 8, brown). Data analysis was performed using the homogeneity test, Kolmogorov-Smirnov normality test, and Pearson Correlation test.

Study Protocol

Subjects are required to fast for approximately 6-8 hours since the night. Thirty minutes before the test was given 500 ml of drinking water (Syafriani et al., 2014). Data collection was carried out in the morning starting at 07.00 a.m., with an indoor setting, aiming to reduce the number of fluid interventions inside the body. The data (heart rate, percentage of water in the body and urine color) were taken before the Bleep test (first taking), then Bleep test was carried out, continued immediately after Bleep test, second data taken. After completing second data collection, the subjects were instructed to rest for a while without any fluid intake. After 15 minutes of rest, the third data collection was carried out. Finally, the fourth data collection was carried out 30 minutes after the *Bleep test*. This protocol refers to several previous studies on data collection that are observational

and related to acute post-exercise effects (Dow et al., 2019; Pritchett & Pritchett, 2013; Syafriani et al., 2014).

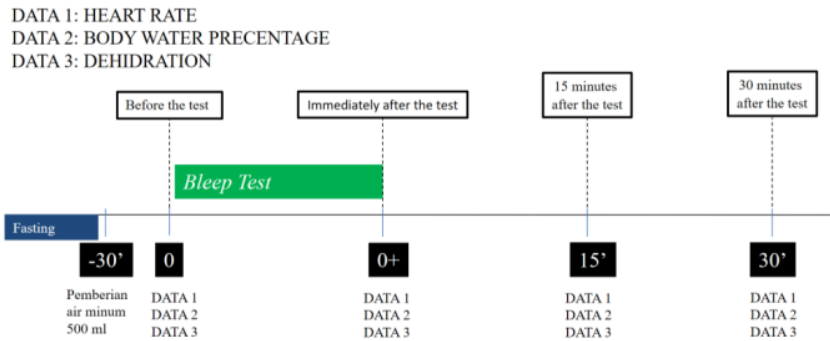


Figure 1. Study protocol

Ethical Clearance

This research protocol was confirmed by Ethics Committee Approval of PKU Muhammadiyah Hospital with reference number: 00169/KT.7.4/VI/2021, and declared to be ethically appropriate in accordance to seven WHO 2011 standards.

RESULT

The average age of study subjects was 19 years old, with an average height and weight of 163 cm and 59.8 kg, respectively. There were 29 males and 14 females involved in this study. The mean body mass index in the normal category was 21.9. Meanwhile, from the Bleep test results, the average $VO_2\text{Max}$ of students during the pandemic was 30.2 ± 2.63 ml/kg/minutes (female) and 36.8 ± 5.31 ml/kg/minutes (male) only, categorized as fair category.

Table 1. Average subject description

Subject Description	Average ± SD
Age (years)	19.96 ± 0.64
Height (cm)	163.19 ± 7.33
Weight (kg)	59.8 ± 9.88
Body Fat (%)	20.31 ± 6.22
Visceral Fat	4.7 ± 2.40
BMI	21.97 ± 2.78
BMR	1406.95 ± 207.56
Bleep test	35.73 ± 5.56
Bleep test category	Fair

The heart rate is described in Table 2, where before the test, the heart rate was very low, while immediately after the Bleep test, the heart rate experienced a high increase. It was described with an average of 150 beats/minute, categorized as medium-high intensity. The average test seems not optimal because the test was carried out in the morning and the subject felt their body condition is constrained, heavy when moving. When viewed in detail from the overall data, some people experienced a significant increase of up to 180 beats/minute (90% maximal heart rate). The bleep test forced the subjects to perform maximum performance coupled with the rhythm of the music or the signal of the beeping rhythm that makes the subject have to adjust the speed and frequency of steps.

Table 2. Description of the average heart rate based on the time of collection

Time of data collection	Average heart rate (/minute)	Maximal heart rate percentage (%)
Before the test	80.93 ± 14.11	40
Immediately after the test	150 ± 19.16	70-80
15 minutes after the test	104.65 ± 17.96	50
30 minutes after the test	94.88 ± 16.48	45

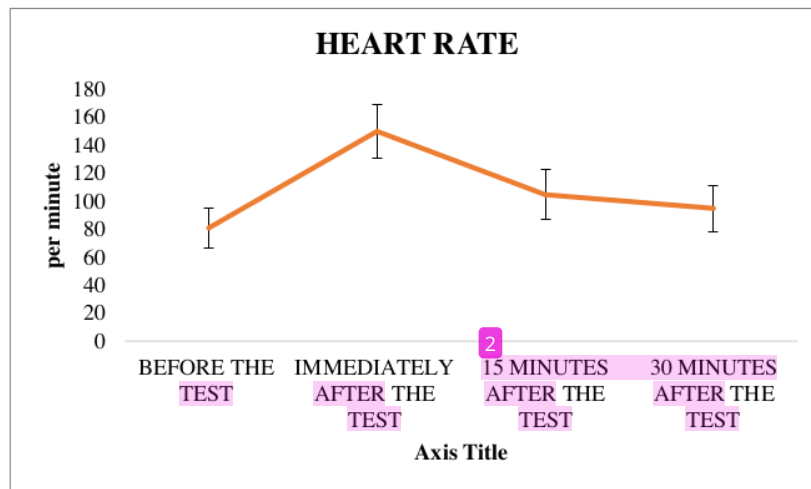


Figure 2. Condition of the heart rate based on the time of collection

The body water percentage remained in a good category, reaching over 50% fluid in the body. There was no significant difference in conditions before, immediately after the test, 15, and 30 minutes. It is discovered that the physical fitness test using the Bleep test method in the field does not make the body lose large amounts of fluid. It remains in the appropriate category.

Table 3. The average body water percentage based on the time of collection

Time of data collection	Average body water percentage (%)
Before the test	54.98 ± 4.58
Immediately after the test	55.25 ± 4.78
15 minutes after the test	55.23 ± 4.69
30 minutes after the test	55.16 ± 4.72

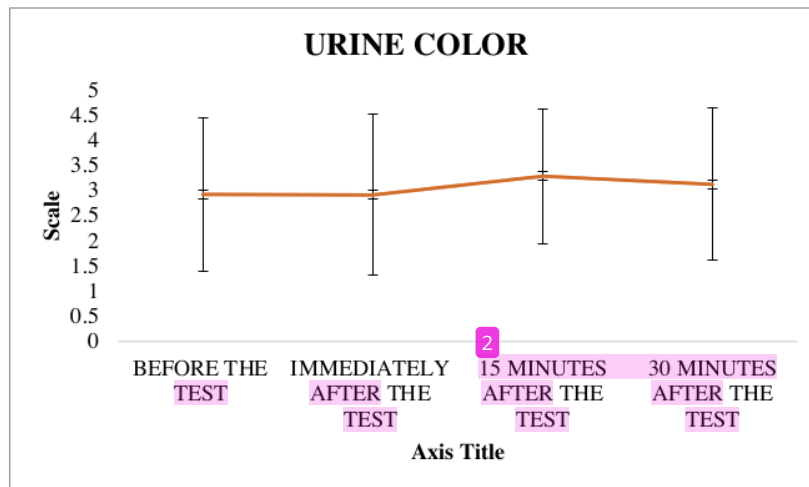


Figure 3. The average body water percentage based on the time of collection

Meanwhile, in the measurement of dehydration using an instrument of urine color, the measurement scale used 1-8: the hydrated category (scale 1, routine white color; scale 2, slightly yellow saturation white; scale 3, a mix of white and yellow), dehydration category (scale 4, majority yellow, slightly white; scale 5, yellow; scale 6, concentrated yellow), and severe dehydration (scale 7, brownish-yellow color; scale 8, brown). The results showed that subjects were not dehydrated with an average urine color of scale 3. Although several subjects fell into scales 5-6 in data collection, the average was used, resulting in the urine condition remain the hydrated category, did not fall into the category of dehydration. The use of urine color is a practical and valid instrument to determine the early symptoms of dehydration.

Table 4. Overview of urine color as an indicator of dehydration based on the time of collection

Time of data collection	Average of urine color (Scale: 1-8)
Before the test	2.92 ± 1.53
Immediately after the test	2.90 ± 1.59
15 minutes after the test	3.28 ± 1.33
30 minutes after the test	3.12 ± 1.51

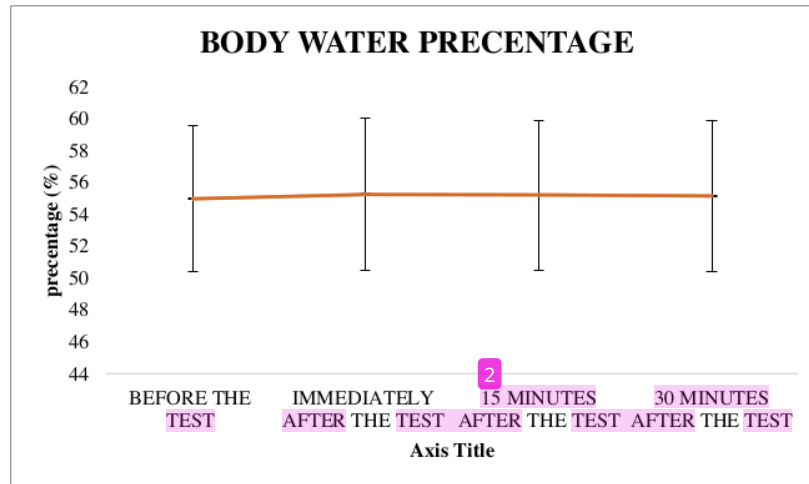


Figure 5. The condition of urine color based on the time of collection

From the data of heart rate, hydration, and urine obtained as samples, the relationship between heart rate and hydration ($0.071 > 0.05$), heart rate and urine color ($0.557 > 0.05$), and hydration and urine color ($0.10 > 0.05$) are shown in Table 2. It reveals that no significant relationship was discovered among the three variables.

Table 5. Correlation of heart rate, body water percentage, and dehydration

No	Variable	Sig.
1	Heart rate – Body water	.071
2	Body water – Urine colour	.100
3	Heart rate – Urine colour	.557

Discussion

Activity patterns have changed since the pandemic online learning system (Al-Kumaim et al., 2021; Coman et al., 2020; Darius et al., 2021; Giatman et al., 2020; Radu et al., 2020; Xhelili et al., 2021) affects the pattern of physical activity with a tendency to decrease. Recommendations

from WHO regarding the physical activity of three times a week with an accumulated time of 150 minutes per week and moderate intensity (World Health Organization, 2020) is questionable in the application during the Covid-19 period, which has hit Indonesia for almost two years. The declining trend of fitness conditions is the reason for the emergence of this study to investigate more deeply and be carried out practically to discover the challenges faced in fitness or immunity during a pandemic, starting with the fitness profile of sports students during the pandemic. From the study results, it is clear that the student's fitness condition was fair. Poor active behavior during the pandemic is the leading cause of the phenomenon of declining fitness conditions. The study results align with a study traced from several regions in Indonesia and (Widodo et al., 2020), although there was a group whose fitness level was in good condition (Puspitasari, P. W., & Rizky, 2021).

Physical fitness will correlate with several components related to health, such as heart rate, body water percentage, and dehydration during physical activity. Heart rate can be used as a predictor of exercise intensity. The work of the heart should be more effective and efficient when doing the Bleep test for active people in sports or athletes. For athletes, the efficiency of pumping blood by the heart occurs due to long-standing adaptations according to training age. For anaerobic-dominant athletes, the expected adaptation is an enlargement of the heart muscle, while in aerobic-dominant athletes, an increase in heart volume or size is expected with the belief that the efficiency of a large blood pump in one heartbeat can be achieved (Porcari et al., 2015). The habit of measuring the maximum lung capacity causes the body to feel the maximum work stimulation in helping to exert energy during the fitness test. If observed from Graph 1, the illustration of the heart rate that adjusts to workability follows various previous studies related to the cardiovascular work system (G. A. Brown et al., 2010). The intensity increases as the body's maximum workability must be achieved during the test (Kenney et al., 2015), usually marked with lactate as an indicator of fatigue (Akinici et al., 2020; Brini et al., 2019; Potter & Fuller,

2015). Maximum aerobic ability and heart rate variation will increase with the intervention of physical activity (Sharma et al., 2017). Previous studies on the fitness test treatment showed that VO₂Max ability had an opposite relationship with resting heart rate, associated with exercise age, fitness, and body mass index (Fan et al., 2020). Hence, the higher a person's VO₂Max value, the lower the heart rate, compared to untrained individuals or are not physically active.

Fluid intake during exercise is essential and must be considered before, during, and after exercise (Armstrong, 2021; Je´quier & Constant, 2010; Kenefick & Cheuvront, 2012; McDermott et al., 2017). For sports that are carried out for less than 60 minutes, the reduced fluid can be replaced with mineral water intake only (Je´quier & Constant, 2010; Porcari et al., 2015). If the exercise duration ranges from 60 – 120 minutes, then mineral water alone is not enough, but an additional intake of electrolytes contained in sweat as metabolic waste is also required (Armstrong, 2021; Porcari et al., 2015), usually contained in milk (Amiri et al., 2019; Castro-Sepúlveda et al., 2016; Dow et al., 2019; Russo et al., 2019) and coconut water (Syafriani et al., 2014). After more than two hours of physical activity, in addition to water and electrolytes, it is also necessary to have an additional intake containing carbohydrates and protein which are usually only found in milk. (James et al., 2019) or sports gel (Dow et al., 2019; Kenefick & Cheuvront, 2012; Porcari et al., 2015). It can be concluded that before, during and after exercise, fluid intake is very important. For example, there are still many teenagers who ignore fluid intake and replace it with sports drinks (Mata et al., 2021). Even though it has long been published that the essence of the safest fluid intake can be found easily through mineral water (Je´quier & Constant, 2010), but the consumption of mineral water alone is still a lot of teenagers who pass it. This bad habit causes the color of urine to become brownish yellow, if it occurs every day, kidney function will deteriorate. A study explained that adolescents' knowledge of food and beverage intake was negatively correlated with application in everyday life. It indicates that knowledge alone is not enough, but there is a need for reminders and

guidance in applying food and beverage intake patterns. However, many studies explained that athletes or ordinary people are motivated to learn and improve food and drink intake patterns (Patton-Lopez et al., 2018).

A body water percentage can be determined by the fluid consumption habits of each individual. The more fluids consumed, such as drinking water, electrolyte drinks, and electrolyte drinks with additional carbohydrate and protein content, the better the body's work will be in supporting each activity. From a biochemical perspective, water plays a role in chemical reactions, coupled with a catalyst, i.e., enzymes, making the ability to carry out reactions in the body occur quickly. Fluid intake is vital so that a person can meet the fluids in the body to work to break down chemical reactions that occur during the body's activities (Galloway, 2011). The minimum goal is that all individuals know the importance of drinking before, during, and after practice or competition (Bibiloni et al., 2018). After educating people on the importance of fluid intake, implementation in the field will be easier since each individual is aware of the benefits of drinking as recommended (Bibiloni et al., 2018; Mohd Elias et al., 2018; Patton-Lopez et al., 2018; Purcell, 2013; Zaman et al., 2021). Good hydration will affect a person's focus when doing movements (Perrier, 2017; Pritchett et al., 2020).

It is necessary to observe if someone has been doing sports for a long time, but it turns out that they are experiencing a lack of fluid intake without realizing it. It may happen in teenagers actively playing futsal. It turns out that they are at risk of lack of fluid intake due to being undisciplined and not educated about the importance of replacing lost fluids (Zein et al., 2020). An instrument to determine whether a person is dehydrated can be easily identified by the urine color (Kavouras et al., 2016), although there are pros and cons to the recommended use of urinary (Bongers et al., 2018). However, from the practicality and effectiveness in helping data collection quickly due to repetition of data collection, it is better to use urine color as the main choice (Kavouras et al., 2016). From the urine color, indications of dehydration were indicated on scales 7 and 8, where the urine color was brownish, even dark brown. To prevent the occurrence of yellow-brown and

dark brown urine, it is a good idea to drink eight glasses of water a day to be appropriately fulfilled (Kemenkes RI, 2020; Kenefick & Cheuvront, 2012). In this study, it was found that several subjects in the morning had a dark yellow urine color; after being traced, it turned out that the habit of consuming tea and vitamins affects the work of the kidneys, resulting in yellow urine (into the urine color scale 4-6) which indicates that there is an infection. Dehydration is usually characterized by loss of focus (Perrier, 2017; Pritchett et al., 2020), muscle cramp (Maughan & Shirreffs, 2019), heat stroke (Kenney et al., 2015; Porcari et al., 2015), and the worst is collapsing (Khorram-Manesh et al., 2020; Lünig et al., 2019; Thorsson et al., 2021).

The early symptoms of dehydration are usually not realized by many people. Repetitive physical activity has a high risk of dehydration. For example, in Indonesia, festivals or competitions from early childhood to youth are usually held with several matches per day. It has an impact on the physiological aspects of sports actors who will experience fatigue. The fluid intake has not been fulfilled due to the first strenuous activity. After a few hours, the match must be restarted. According to previous references (Porcari et al., 2015), most individuals engaging in such activities will experience excessive fatigue, including weakness, loss of focus, and dizziness. In some cases, some experience fainting due to the hectic schedule of matches in a day. Festivals or competitions like this have occurred since an early age; it is hazardous for young children if they do not get education and guidance from experts. In overcoming this, it is necessary to intervene from practitioners in nutrition and sports physiology so that the competition climate produces favorable conditions for both the organizers, participants, and parents.

Based on the study results, it is discovered that decreased physical fitness conditions, especially in late adolescence (students), occur significantly. Being in front of the screen due to online learning affects fitness, as evidenced by the fair category of all subjects participating in this study. There needs to be intervention from experts and practitioners, as well

as technological development innovations, to be able to help improve physical activity habits. Heart rate, body water percentage, and dehydration are not positively correlated, but the three components have their respective roles in helping the body carry out its functions in supporting daily physical activities. The acute response data obtained is expected to make practitioners and academics aware that maximum work will make the body adapt as soon as possible. There needs to be a structured exercise program intervention to assist in improving fitness abilities. It can be said that there was detraining due to the lockdown period being too long during the pandemic. In following up on this phenomenon, practitioners and academics need to synergize in order to improve fitness conditions in bulk with innovative programs, besides that the body's adaptation to various stimulations given during exercise needs to adjust to the principle of individualization (Fuchs, 2015; Kenney et al., 2015; Porcari et al., 2015), so that the improvements obtained are right on target and have a good impact slowly.

CONCLUSION

Physical fitness components on sports students are fair category, both male and female. Meanwhile, all variables have their work functions, respectively, that are proved by the insignificant relationship between heart rate, body water percentage, and dehydration while doing the *Bleep test* during the pandemic.

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