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Research article

A BOARD MADE OF PLASTIC BOTTLES: A FUNCTIONAL, ECOLOGIC AND ECONOMIC ALTERNATIVE FOR LEARNING STAND UP PADDLE BOARDING

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Abstract. *The main aim of actual research is to determine whether using the alternative board made of plastic bottles in comparison to conventional board affects the learning and practice of Stand up paddle (SUP) boarding. A sample of 16 healthy participants were recruited for convenience (aged M=23.5 years, CI95%: 21.62–25.54; body height M=170.13 cm, CI95%: 165.00–175.51; body mass M=69.63 kg; CI95%: 62.37–77.72) and randomly assigned to two groups: a) Conventional Material (CM; n=8) and; b) Alternative Material (AM; n=8). As criteria of learning, we considered variables as the number of falls, balance, body control, movement pattern of the paddling and the amount of time required to get stability on the board. No differences between groups in any criteria were found. We also observed that producing a board made of plastic bottles is 20 times cheaper than purchasing a conventional board made of resin. It can be concluded that the recycled board is as functional as a conventional board, but cheaper and less damaging to the environment.*

Key words: *Alternative Materials, Surf, Physical Activity, Water Sport, Sports Learning*

INTRODUCTION

Stand up Paddle (SUP) boarding is a sport modality that includes features from surf and paddling, and has been one of the sports with more practitioners in the last years (Ruess et al., 2013a, 2013b; Schram, Hing, Climstein, & Walsh, 2014). SUP boarding is practiced

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using a surfboard that measures from 3 and 5 meters long per 70 to 90 centimeter wide, and a paddle that is used to move the board across the water (Ruess et al., 2013a; Elling, Kranz, Leikert, & Tresh, 2014; Schram et al., 2014). Practicing SUP boarding providea several physical and mental benefits, since it requires constant activation of most skeletal muscles, such as, the core muscles (Zeni, 2002; Ruess et al., 2013b) and improves mental welfare due to its relaxing effects, which is commonly in aquatic activities (Taylor, Sallis, & Needle, 1985; Ayán, Carvalho, Varela, & Cancela, 2017).

Physical capacities including neuromuscular interaction and body expression are highly implicated in SUP boarding performance. However, the material used in the board confection is also considered an important variable for a good performance of SUP practitioners (Zeni, 2002; Ruess et al., 2013a, 2013b; Schram et al., 2014). So, conventional SUP boards are made of soft and functional materials, such as epoxy resin, fiberglass and expanded polyurethane foam. However, the high cost of these materials (Jesus, Gordilho Neto, Cequeira, Costa, & Santos, 2013) makes the acquisition of a SUP board difficult to the low-income population (Zeni, 2002; Grijó & Baasch, 2003; Carozza, 2013; Schram et al., 2014). Moreover, several chemical processes are implicated in the board confection and around 60% of the discarded materials negatively impact the environment (Grijó, 2004; Grijó & Brügger, 2011; Souza, Machado, Reis, Santos, & Dias, 2013). To minimize environment damage and to facilitate access to the SUP board practice for the low-income population, a Brazilian surfer created a board using plastic bottles. Due to confection facility, this model of the board has been used by different social classes (Glock, 2013; Lumertz, 2015).

Although recyclable materials have been used in different physical activities, including surfboarding (Lumertz, 2015), weight training and functional training (Avelar-Rosa & Figueiredo, 2011; Barros & Oliveira Neto, 2012; Skowronski, 2014), and that different type of materials can affect individual performance on physical activities (Horak, Nashner, & Diener, 1990; Houglum & Bertoti, 2014). However, no studies have been conducted to investigate the effectiveness of recyclable SUP boards on learning and daily practice.

The main aim of the current research is to determine whether using the alternative board made of plastic bottles in comparison to the conventional board affects the learning and practice of SUP boarding.

METHODS

Participants

A sample of 16 healthy participants were recruited for convenience (aged M=23.5 years, CI95%: 21.62–25.54; body height M=170.13 cm, CI95%: 165.00–175.51; body mass M=69.63 kg; CI95%: 62.37–77.72). The criteria for participation in the study were no previous experiences with surfboard activities. And, in order to minimize error, no participants with motor or learning disfunctions were included in this study. The participants were randomly assigned to two groups: a) Conventional Material (CM; n=8) and; b) Alternative Material (AM; n=8). All of the participants were informed of all procedures and the aim of this study, and gave informed consent before beginning the study. All procedures were approved by ethics committee of University of Mogi das Cruzes (#1.082.190/2015).

Materials

To carry out this study, two SUP boards were used, including a conventional board and an alternative board. The conventional board was made of expanded polystyrene foam (EPS), epoxy resin and fiberglass (Seven Seas brand), measuring 307 ×80×11 centimeters (length × width × thickness), with a density of approximately 0.05 gr / cm³ and supported up to 110 kilograms (kg). The alternative board was made of 93 2-liter PET bottles. The dimensions of the alternative board were 290x70x 10 centimeters, with an approximate density of 0.06 gr/cm³ with an adequate support for 100 kg. All participants used similar paddles (198 centimeters long).

Alternative Board

The confection of the alternative SUP board was performed according Lumertz (2015) guidelines. For this, we used 50 whole plastic bottles and 43 cut bottles (removing the top and the bottom). The whole bottoms were air-filled with a manual air pump until their walls were poorly malleable. After this, the exterior tips of the whole bottles, and the interior walls of the cut bottles were sanded with a 120 grit wet sandpaper to provide better adhesion to glue. Finally, the cut bottles were used as connectors to make 7 columns of 6, 7 or 8 whole bottles. An expansive polyurethane glue was used to link the materials.

The bottles of the tip were tilted up to provide a proper angulation to reduce water friction. Soon after, the columns were joined. So, columns with 8 bottles were placed at the center of the board, and the columns were placed on both laterals.

To reinforce the board structure, 6 pairs of 25 mm diameter polyvinyl polychloride (PVC) tubes were fixed between the bottle columns. Thus, two PVC pipes measuring 2.50 meters long were placed between the center columns and a pair with 2.40 meters was put between the columns composed of 8 and 7 bottles. Finally, a pair of 1.80-meter-long tubes were placed between the 7 and 6 bottle columns.

The alternative board deck was made with a 400 x 600 x 5 mm (length x width x thickness) sheet of ethylene vinyl acetate. To fix the deck to the upper surface of the board a contact adhesive was used. Thus, it was possible to improve the grip and reduce irregularities caused by the corrugations of the bottles and tubes used (Figure 1). To ensure the bonding process, the structure was held together with tape and kept at rest for 24 hours.

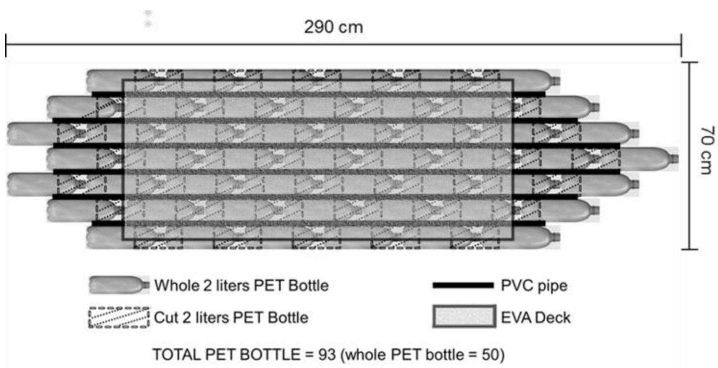

Fig. 1 Project of the PET bottle board

After the glue dried, the flotation and stability of the PET bottle board were tested. To do this, a SUP instructor (mass=90 kg) performed two SUP training sessions in an Olympic pool. In the first session, every 10 minutes of practice, 5 kg of mass was added to the center of the alternative board. The maximum mass supported by the alternative SUP board was 110 kg. During this first stage, the SUP instructor considered that 100 kg is the mass limit for practicing SUP on the alternative board.

In the second session, the SUP instructor performed 30 minutes of practice on the bottle board with 10kg added to the deck (total mass=100kg). After the second stage of the experimental test, the structural consistency of the bottle SUP board was reevaluated. No damage occurred to the structure and we did not notice any conditions that could impair SUP practice or offer any risk to the practitioner, so the alternative board was considered ready for use.

Procedures

We elaborated a learning method based on the guidelines of SUP learning, described in the handbook of Stand-Up Paddle Boarding Award supported by the American Canoe Association (Boys Scouts of America, 2013). Due to a lack of information in the literature about the proper time required for SUP boarding learning, we stipulated a maximum period of 10 days of training with a duration of 40 minutes per day and intervals from 2 to 3 day between sessions. However, the training protocol was considered done when the participants were able to achieve all the requirements properly, including the movement patterns of paddling, body and board control. The whole protocol occurred in a swimming pool that measures 50 × 25 meters (length x width), of a club, of the city of Mogi das Cruzes, São Paulo, Brazil.

In the first session, participants were briefly instructed about the board structure (nose, tail, bottom, deck, deck pad and fin), how to perform the movements properly (paddling and standing up on board). After the introductory instructions, participants were submitted to the practical training of SUP. To familiarize participants with the SUP boarding, we instructed them to start in a kneeling position for the first 10 minutes. Afterwards, they were required to perform the practice standing. In the second session, participants were oriented to start the training in standing position; however, they could start it kneeling if necessary. The sessions were performed with one participant from each group in the swimming pool under favorable weather conditions. During the tasks, participants were instructed to perform the stipulated route in the shortest possible time. Every five minutes instructions and positive feedback about movement pattern were provided to them, respectively.

From the moment that the participant mastered the taught technique, a learning test was applied. And after 15 days without practicing SUP boarding, a retention test was applied to assess persistence on the learned skill was applied. The tests required the participant to go around the swimming pool, bordering it to both the right and left sides. Different criteria were considered, including: a) movement patterns for a proper performance; b) balance (capacity to keep the movement rhythm without body destabilization; c) number of falls; d) time spent to control body movement; e) time used to guide the board and; f) time taken to complete the learning task. In both tests, 2 trials were allowed per participant. A timer was used to register the time spent in both tests. In order to minimize observational bias, all tasks and tests were recorded using 2 digital cameras Samsung (model WB150F, 12 MP) and a digital video camera GoPro (model Hero 3+ Black Edition, 12 MP).

Statistical analysis

Our data were analyzed by the Generalized Estimating Equations test, adjusted for gamma distribution and an unstructured working correlation matrix. The results were analyzed using SPSS statistical software (version 24 for Windows, IBM®). The values were expressed as mean and confidence interval (95% CI).

RESULTS

Motor variables and time of performance

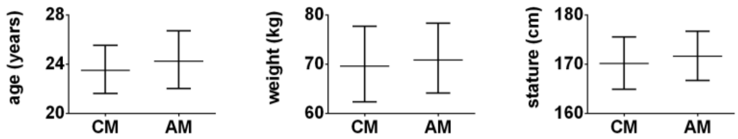

Fig. 2 Mean and confidence interval values (95%) of age, body mass and stature of the groups Conventional Material (CM) and Alternative Material (AM)

In our study, we found that number of falls achieved by CM and AM groups were 4.2 (95% CI: 2.19–8.06) and 3.4 (95% CI: 1.75–6.61), respectively. The number of imbalances in the MA group was 5.71 (95% CI: 3.32–9.85) and in the CM group was 3.5 (95% CI: 2.48–4.93). The mean of session required for the AM group to control body movement was 2.63 (95% CI: 2.18–3.15) and for the CM group it was 2.13 (95% CI: 1.75–2. 58). The required mean of sessions to perform the paddling movement properly was 3 (95% CI: 3.00–3.00) for the MC group and 2.71 (2.40–3.07) for the MA group. Considering the board direction control task, we observed that the mean of days required to guide the board properly was 1.75 (95% CI: 1.14–2.69) for the MC group 1.63 (IC 95 %: 1.21–2.19) for the MA group. In addition, the MA group completed the task in 3.13 (95% CI: 2.90–3.36) sessions and the MC group used 3 (95% CI: 2.67–3.37) sessions to complete the task. The GEE test revealed no significant difference between the groups for the following variables (falls: χ^2=0.198, p=0.656; imbalance: χ^2=2.230, p=0.155; body control: χ^2=2.383, p=0.123; correct paddling: χ^2=2.531, p=0.112; board control: χ^2=0.077, p=0.792; task: χ^2=0.342, p=0.559) (Figure 3).

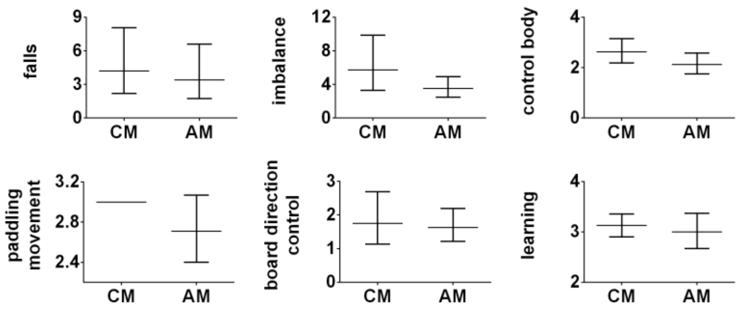

Fig. 3 Mean and confidence interval values (95%) of the number of falls, imbalance and training sessions necessary to correctly perform body control, padding movement, board direction control and completion of the task of both groups

Learning and retention tasks

In learning task performance, the CM group required 160.88 (95% CI: 149.17-173.51) seconds to complete the turn clockwise and 156.25 (95% CI: 144, 52-168.93) seconds to turn counterclockwise, bringing a total of 317.13 (95% CI: 293.97-342.11) seconds. In this same variable, the AM group required 165.89 (95% CI: 145.47-189.17) seconds to complete the clockwise turn and 165.29 (95% CI: 145.76-187, 44) seconds the counterclockwise turn, totaling 331.18 (95% CI: 292.81-374.58) seconds.

In the retention task, the CM group spent 130.73 (95% CI: 120.97-141.27) seconds to perform the turn clockwise and 121 (95% CI: 112.26-132.58) seconds counterclockwise. Considering the total time, the CM group showed 252.73 (95% CI: 233.43-273.62) seconds. Meanwhile, the AM group scored 134.92 (95% CI: 119.90-151.81) seconds for the clockwise turn and 131.65 (95% CI: 117.97-146.92) for the counterclockwise turn, totaling 266.57 (95% CI: 238.05-298.51) seconds.

The GEE test showed significant differences between tasks (learning x retention, χ^2=51.317, p<0.001). However, no significant difference was found between groups (χ^2=0.204, p=0.652). We also observed no interaction (groups*tasks; χ^2<0.001; p=0.988) in the time spent to perform the clockwise turn. Therefore, independently of the group, for each second spent in the tasks, the clockwise turn in learning task was 0.208 seconds longer than in the retention task (95% CI: 0.130-0.285, p<0.001). The same effect was observed in the time spent performing the counterclockwise turn (group: χ^2=0.960, p=0.327, task: χ^2=74.893, p<0.001, interaction: χ^2=0.132, p=0.717) and (group: χ^2=0.518, p=0.472, task: χ^2=70.187, p<0.001, interaction: χ^2=0.035, p=0.851). In this context, regardless of the group, for each second of activity, the time spent to complete the counterclockwise turn in the learning task increased 0.247 seconds when compared to the retention task (95% CI: 0.169-0.326, p<0.001). In the total time, the learning task increased 0.388 seconds for every second of activity when compared to the time spent on the retention task (95% CI: 0.151-0.303, p<0.001) (Figure 4).

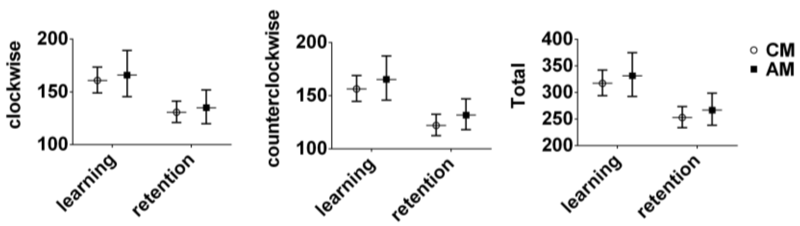

Fig. 4 Time in seconds required by both groups to perform the learning and retention tasks

DISCUSSION

Although prior studies reported that different factors such as the environment, admeasurement and materials affect motor performance (Horak et al., 1990; Brunetti, 2008; Magill, 2011; Ruess et al., 2013a; Houglum & Bertoti, 2014), in our study it was observed that the usage of a board made of recyclable materials did not impact the time spent learning SUP boarding, the number of falls and unbalances nor in the amount of training required to complete a trajectory by performing adequate movements of the SUP.

Considering the general time spent to learn the task, we observed that all participants learned it over a short period of training (3 sessions) independently of the type of material of the board used during the protocol training. Probably, this short time achieved for learning SUP boarding is associated with the early stage of motor skills acquisition, when the improvement of motor development is expressive (Walker et al., 2003). Moreover, during the first session of training, participants of both groups reported the same difficulties, including maintenance of the balance, tremor, pain and muscle fatigue in lower limbs. However, in the second session the participants conveyed no muscular discomfort and they were able to maintain the balance more easily on the board. These physical improvements can occur due to neuromuscular adaptation induced by the motor learning process (Horlings, van Engelen, Allum, & Bloem, 2008; D'Elia, 2013; Behrens, Mau-Moeller, Wassermann, Bader, & Bruhn, 2015). Neuromuscular adaptations are characteristics of the assimilation processes and learning accommodation that involves perception and body adjustments (Teixeira, 2006; Leonardi, Galatti, Paes, & Seoane, 2014). Moreover, the exercise-induced neuroplasticity can be observed in the early hours of the first training session (Toni, Krams, Turner, & Passingham, 1998; Ungerleider, Doyon, & Karni, 2002; Floyer-Lea, 2005).

When analyzing motor performance, we also noticed that the number of falls and the difficulty to maintain balance on the board were similar for participants of both groups. Furthermore, no differences were found between groups on the time spent completing both the learning and retention tasks. Although several studies reported that materials with different characteristics can impact motor performance (Horak et al., 1990; Brunetti, 2008; Magill, 2011; Ruess et al., 2013b; Houglum & Bertoti, 2014), here, we observed that the plastic made board was as effective as the resin board to provide motor learning. In this view, the little density found between them may not have been enough to interfere in the learning time and balance. However, further studies are required in order to investigate the influence of the density of a SUP board on motor learning.

Surprisingly, we noticed that both groups were able to perform the task in the retention test in a shorter time than in the learning test. This decrease was observed in the time spent to return to both sides (right and left) and in the total time, indicating that both groups learned SUP boarding effectively. The time reduction found in the retention test may be associated to the process of motor learning that is implicated in the improvement stages, including cognition, assimilation and movement automation (Teixeira, 2006; Magill, 2011), i.e., the period that participants performed without training SUP boarding may have been induced neurophysiological adaptations that allowed a better performance on the retention test. Curiously, still in the retention task, the group that used the conventional SUP boarding performed the route back to the left than to the right side. We believe that this outcome might be associated to sensory-motor and neurological mechanisms. That is because the motor performance is directly connected to motor coordination that involves capturing and sending stimuli conducted through afferent and efferent neural structures (Horlings et al., 2008). In addition, the lateral asymmetry in motor performance may be related to asymmetric brain development. However, motor asymmetry does not present a universal standard (Grafton, Hazeltine, & Ivry, 2002; Garry, Kamen, & Nordstrom, 2004; Teixeira, 2006; Bond, Cook, Swartz, & Laroche, 2017), which may justify the fact that the group that used the alternative board did not present any difference in the time spent performing the turns to both the right and left sides.

Our outcomes suggest an important alternative to the SUP boarding practice, since we found that we can produce an effective SUP board using recyclable materials such as plastic bottles. Besides the benefits that it may generate for nature, producing this type of board might facilitate the access to this sport due to the low production cost observed in our study. Furthermore, even our results showed that learning is not impacted by the type of material, further studies should assay the adaptability of the skill applying a transfer test by exchanging the boards between groups in order to provide all the information implicated in motor learning (Teixeira, 2006). We would also like to emphasize that our investigation was conducted in a swimming pool of a college where no nature variation occurs; however, SUP practicing is generally performed in nature such as the sea and rivers, where natural events may affect the SUP boarding performance and the structure of the board. Based on this, additional studies should assess environmental adaptability by conducting a transfer test in natural environments.

CONCLUSION

Here, we observed that the fact of using an alternative board did not affect the learning and practice of SUP boarding. Based on this, it can be concluded that using a board made of plastic bottles is a functional, economic, and environmentally friendly alternative to practice SUP boarding on calm waters and can replace the epoxy resin SUP board.

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DASKA IZRAĐENA OD PLASTIČNIH BOCA: FUNKCIONALNA, EKOLOŠKA I EKONOMSKA ALTERNATIVA ZA UČENJE SURFINGA

Glavni cilj aktuelnog istraživanja je da se utvrdi da li upotreba alternativne daske napravljene od plastičnih boca u poređenju sa konvencionalnom daskom utiče na učenje i uvežbavanje surfing (prema engl. Stand up paddle-SUP). Uzorak 16 zdravih učesnika regrutovan je radi pogodnosti (stariji M=23.5 godina, CI95%: 21.62-25.54; telesna visina M=170.13 cm, CI95%: 165.00-175.51; telesna masa M=69.63 kg; CI95%: 62.37-77.72) i nasumično svrstan u dve grupe: a) konvencionalni materijal (CM; n=8) i; b) alternativni materijal (AM; n=8). Kao kriterijum učenja, u obzir smo uzeli varijable kao što su broj padova, ravnoteža, kontrola tela, obrazac pokreta veslanja i vreme potrebno za postizanje stabilnosti na dasci. Nismo pronašli razlike između grupa ni u jednom kriterijumu. Takođe smo zapazili kako je izrada daske napravljene od plastičnih boca 20 puta jeftinija od kupovne konvencionalne daske izrađene od smole. Obzirom na sve navedeno, zapazili smo da je reciklirana daska funkcionalna kao i konvencionalna daska, ali jeftinija i manje štetna po prirodu.

Ključne reči: *alternativni materijali, surfing, fizička aktivnost, vodeni sportovi, učenje sporta*