ABSTRACT. The aim of this study is to determine the intensity of competitive effort by measuring the heart rate of female players of beach handball. For this purpose, we employed a sample of six players belonging to the same team.

During the course of 13 matches (national level category), heart rate was recorded for all players by telemetry in periods of five seconds. The average values of heart rate recorded in the first half was 149.94±11.96 bpm representing 80% reference HRmax with a minimum of 113.20±13.65 bpm and a maximum 172.16±9.97 bpm while in the second half was 156.08±11.43 bpm assuming 83% referente HRmax, with a minimum 125.16±14.99 bpm and a maximum of 175.94±8.94 bpm.

Following the classification of intensity of physical activity proposed by the ACSM we registered that during the activity time in the first half was 41.57±19.7% defined as vigorous activity and in 26.1±26.5% as very vigorous; during the second half the moderate percentage activity for increased the very vigorous activity percentage 40.8±25.5% was reduced.

The results suggest that the practice of beach handball is a vigorous and very vigorous activity during 70% of the total activity time. The heart rate registration will remain between 150 and 157 bpm representing the 80-83% reference HRmax.

Key Words: Beach Handball, Effort, Intensity, Heart Rate, Female.

INTRODUCTION

Nowadays, beach handball is a discipline recognised by several international federations and practised by nearly 400,000 people around the world. Participants are usually indoor handball players who continue playing in the summer.

Oddly, this sport goes back to the 80’s in Holland and Italy, places with scarcely any handball tradition. Federations have been gradually taking part in this popular sport, finally formalising a sports and organizational regulation in 2002, i.e. European Handball Federation, 2005ª.

Beach handball is played in a 15x12m sand field. Each equipment has 1 goalkeeper and three (3) players of field that compete during two halves of 10 (2x10) minutes each. They follow the applicable rules of indoor handball, with the exception of the zone of change, which is an entire band for each team, and the score of the goalkeepers, which counts double (European Handball Federation, 2005b).

Knowing about the intensity of a physical activity is fundamental to determine training goals and its planning later on. Assuming the impossibility of applying the same conditions of a laboratory test to a group activity, heart rate recording is the solution. Knowing about the effort demanded of our heart, we can determine the energy level that an activity needs and then we can determine the training goals to be more efficient when the effort is required. There is literature about football (Barbero-Alvarez, Soto, Barbero-Alvarez, & Granda-Vera, 2008; Esposito et al., 2004), hockey (Konarski, Matuszy=ński, & Strzelczyk, 2006), basketball (Matthew & Delextrat, 2009; McInnes, Carlson, Jones, & McKenna, 1995) and tennis (Christmass, Richmond, Cable, Arthur, & Hartmann, 1998; Loftin, Anderson, Lytton, Pittman, & Warren, 1996). All of them include a recording of heart rates by telemetry, a valid system of
measurement (Laukkanen & Virtanen, 1998; Noakes, Lambert, & Gleeson, 1998; Terbizan, Dolezal, & Albano, 2002). It gives us information about heart response when performing exercises that express a huge variability of intensity (Moore, Lee, Greenisen, & Bishop, 1997) and, at the same time, it gives us an energetic estimation about the performed exercise (Fudge et al., 2007).

There is a conceptual and experimental blank within the study of intensity in beach handball. However, there exist several studies concerning indoor handball. Articles included in the literature of this study such as (Alexander & Boreskie, 1989) or (Loftin et al., 1996) make reference to the Spanish Basque Ball, called “Handball” in USA. For this reason, the first reference is from (Rannou, Prioux, Zouhal, Gratas-Delamarche, & Delamarche, 2001) with players at national and international level category. (Gorostiaga, Granados, Ibanez, & Izquierdo, 2005) also followed this study, although its purpose was not the control of effort intensity, and (Buchheit et al., 2009; Gintaré Onusaitytė, 2009) where heart rate in this physical activity is specifically investigated. A special reference has to be made to Gintaré (2009), since he carries out the same proposal as ours but concerning indoor handball instead.

**METHODOLOGY**

**Sample**
The sample has been obtained from a national female team. It was constituted of 6 players belonging to the same team.

The characteristics of the sample involved in this study are analysed in Table 1.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Height</th>
<th>Weight</th>
<th>Mets</th>
<th>VO₂max</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>19</td>
<td>164</td>
<td>51</td>
<td>14.5</td>
<td>50.75</td>
<td>31.1</td>
</tr>
<tr>
<td>2</td>
<td>23</td>
<td>182</td>
<td>73</td>
<td>16.4</td>
<td>57.4</td>
<td>40.1</td>
</tr>
<tr>
<td>3</td>
<td>38</td>
<td>174</td>
<td>107</td>
<td>14.1</td>
<td>49.35</td>
<td>61.5</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>166</td>
<td>60</td>
<td>16.4</td>
<td>57.4</td>
<td>36.1</td>
</tr>
<tr>
<td>5</td>
<td>27</td>
<td>171</td>
<td>67</td>
<td>14.5</td>
<td>50.75</td>
<td>39.2</td>
</tr>
<tr>
<td>6</td>
<td>21</td>
<td>172</td>
<td>79</td>
<td>14.1</td>
<td>49.35</td>
<td>45.9</td>
</tr>
<tr>
<td>Mean</td>
<td>24.3±7.4</td>
<td>171.4±6.37</td>
<td>77.83±19.39</td>
<td>14.9</td>
<td>52.5±3.85</td>
<td>42.31±10.58</td>
</tr>
</tbody>
</table>

Table 1.

Working intensity was classified following the criteria proposed by Woolford and Angove (1991) and ACSM recommendations: Very Vigorous Activity (>85% HRmax), moderate activity (80-65% HRmax) and low intensity (<60% HRmax) (Armstrong et al., 2006).

<table>
<thead>
<tr>
<th>Participant</th>
<th>FCmax</th>
<th>&gt;80%</th>
<th>Btwn n80%-70%</th>
<th>&lt;60%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>183</td>
<td>146.4</td>
<td>128.1</td>
<td>109.8</td>
</tr>
<tr>
<td>2</td>
<td>177</td>
<td>141.6</td>
<td>123.9</td>
<td>106.2</td>
</tr>
<tr>
<td>3</td>
<td>210</td>
<td>168</td>
<td>147</td>
<td>126</td>
</tr>
<tr>
<td>4</td>
<td>192</td>
<td>153.6</td>
<td>134.4</td>
<td>115.2</td>
</tr>
<tr>
<td>5</td>
<td>186</td>
<td>148.8</td>
<td>130.2</td>
<td>11.6</td>
</tr>
<tr>
<td>6</td>
<td>184</td>
<td>147.2</td>
<td>128.8</td>
<td>110.4</td>
</tr>
<tr>
<td>Mean</td>
<td>188.66±11.5</td>
<td>150.93±9.21</td>
<td>132.06±8.06</td>
<td>113.03±6.96</td>
</tr>
</tbody>
</table>

**Design**
In this research, we have used a pre-experimental design with group descriptive studies. The measurements were taken during the matches.
Instruments
In order to obtain the heart rate we used Polar S625X heart rate monitors. Their validity and reliability has been studied in newer models with great effectiveness (Gamelin, Berthoin, & Bosquet, 2006; Nunan et al., 2009). The interface unit Polar IrDA USB permitted us to insert the data in an iMac with a 2.4 GHz Intel Core 2 Duo (Parallel) processor and obtain the evolution of heart rate during the whole match by using Polar Protrainer 5 software.

The maxim reference heart rate of each subject was obtained from effort test on treadmill model Daum Electronic Ergo_Run Premium 8. We used a protocol designed by us, with progressive increases on speed and slope every minute of effort, until extenuation. The effort ECG was monitored with a Schiller AT.104PC electrocardiograph. The VO$_{2\text{max}}$ was obtained through specific calculi in relation to the test design. Tests took place at Centre de Medicina de l’Esport de Granollers, under the supervision of MEFIDE Doc. Doñate.

Procedure
The data was collected during the celebration of three classificatory national tournaments and also from the Beach Handball Spanish Championship 2009. 13 matches by 16 participants (players) were analysed altogether. In this study, a descriptive analysis has been undertaken, using means, standard deviations, minima and maxima. Data analysis has been processed with statistics tool SPSS 17.0 version and Microsoft Excel 2005.

RESULTS
The mean analysed within the first half of the 13 matches was 149.94±11.96 bpm, representing the 80% reference HR$_{\text{max}}$, whereas during the second half the heart rate mean recorded was 156.08±11.43 bpm, which represents the 83% reference HR$_{\text{max}}$. Figure 1 shows the distribution of minimum, medium and maximum rate means. Within the first half, HR$_{\text{minima}}$ is 113.20±13.65 bpm, and maximum heart rate is 172.16±9.97 bpm. However, HR$_{\text{minima}}$ is 125.16±14.59 bpm, and HR$_{\text{max}}$ is 175.94 ±8.94 bpm within the second half.

Figure 2 shows the difference between the Minima-Medium and Maximum rate and the comparative between the first and the second recorded half. We can confirm a higher heart response within second halves. Correlations between heart rate mean within the first half and the second half is 0.234, what demonstrates that both means are not related.
Following ACSM classification when defining intensity, very vigorous physical activity (>85% HRmax), moderate activity (80-65% HRmax) and low intensity (<60% HRmax) (Armstrong et al., 2006).

Time was quantified in these heart rates. We observe that, within the first half of the match, 26.1±26.5% of the time is a very vigorous activity, most of time is a vigorous activity, 41.57±19.7%, and 21.2±12.6% is moderate intensity. On the contrary, in the second half, the percentage descends within the moderate stripe to 15.7±11.8% and the percentage of very Vigorous activity rises to 40.8±25.5%.

DISCUSSION
Reviewing the literature, we could not find any articles concerning the goal of our study, so we thought that carrying it out was necessary. Although beach handball does not encounter the same physiological characteristics as indoor handball, we found that a comparison with a close approximation was appropriate, since the involved physico-technical regulations and connotations are the same.

Indoor sports similar to indoor handball such as Indoor Football (Barbero-Alvarez et al., 2008) show a heart rate mean of 172 bmp with 83% of activity time defined as “Very Vigorous” heart rate stripes. As well as other studies, this study points out a difference of heart rate means between the first half, when it is superior, and the second half of the match. While in the first half we recorded 176bpm, which represents the 91.1% of the HRmax, within the second one we found a mean slightly inferior, 172bpm, which represents an 88.1% of the HRmax, an effect that (McInnes et al., 1995) recorded among basketball players during the whole match with an 87±2% of the HRmax, with a mean of 165±9 bpm.

(Matthew & Delextrat, 2009) demonstrated in a study about female basketball players that the heart rate during the real time played was around the 92.3% of HRmax, producing a mean of 170±8 bpm. This same author found out that female basketball players’ recordings during the total time played was 89.1% of the HRmax, entailing a mean of 165±9 bpm. Formerly, (McInnes et al., 1995) had demonstrated the same data in an 89±2% of the HRmax, entailing a mean of 168±9 bpm.
(Konarski et al., 2006) carried out the same study among hockey players, finding out the same first-second half relation, but with less important recordings (130.70±8.52 bpm and 123.70±10.04 bpm).

Indoor handball references lead us to approximate working heart rate around 140-150 bpm, (Monte, Gallozi, Lupo, Marcos, & Menchinelli, 1987). The most representative study, assuming it is the closest technical approximation to “indoor handball” and physiologically due to the fact that the studied range are women, is (Gintarė Onusaitytė, 2009). Team central positions of 10 international level category matches were recorded. Gintarė recorded values from 147 to 193 bpm within the first halves while in the second halves there were recordings from 141 to 192 bpm. As we notice in our study, first half recordings were higher than second halves’, what physiologically leads us to the conclusion that players’ fatigue was the cause.

If we compare the aerobic capacity of our sample 52.5±3.85 VO2max with the studies of people such as (Chaouachi et al., 2009), with a mean of 52.83±5.48 VO2max, (Rannou et al., 2001) with national players with a VO2max of 57.7±3.1 ml/kg/min or (Monte et al., 1987) with 53.2±5 ml/kg/min we will observe that our sample encounters similar lines with them, since all the players we studied were indoor handball players.

Another approximate study was carried out by (Buchheit et al., 2009), assessing heart response in plays of indoor handball and demonstrating means of 175 bpm in this kind of training exercises.

Regardless of all this above, approximating beach handball and indoor handball is not accurate, since both sports are played on different surfaces and dimensions, but scientific evidence has evolved more in this case (indoor handball) and we will count on intensity reference values to compare the level of effort with.

It becomes evident that the goal of this study is the heart rate during the activity time of a whole match (half-time was discarded) and this is not different concerning timeouts during the match, one of the variables that should be taken into account for upcoming studies, as well as the differentiation of the specific place a player takes during the match, since physical effort connotations are very different.
REFERENCES


