applied sciences

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Intermonitor Variability of Garmin Vivofit® Jr. Wristband

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Abstract: The main objective of this study was to evaluate the reliability of Garmin Vivofit® Jr. physical activity (PA) wristbands during daily life physical activities. Six wristbands were randomly selected from a stock of twenty-four. The wristbands were worn by a single four-year-old participant, with three on the right wrist area and three on the left wrist area. To assess device reliability under laboratory conditions on a treadmill (Powerjog, model JM200, Sport Engineering Ltd., Birmingham, UK), the participant wore the six wristbands while performing five work conditions: sitting and standing (30 times per minute, controlled by a metronome), walking at 3 km/h, walking at 4 km/h, running at 5 km/h, and running at 6 km/h. Throughout the six minutes, variables related to physical activity provided by the device, step volume, and minutes of physical activity were recorded using the specific application of the wristband (Garmin International Inc., Olathe, KS, USA). The intraclass correlation coefficients (ICCs) were high for all six wristbands with each other, for both the number of steps taken (ICC = 0.991–0.998) and the number of minutes of PA (ICC = 0.892–0.977). The critical alpha value of the Cusum test was highest at.050 for all wristband associations. In conclusion, good reliability was found among the six wristbands, which could be adopted for field-based research to quantify physical activities.

Keywords: physical activity; children; motion sensor; activity assessment

Citation: Díaz-Quesada, G.; Gimenez-Egido, J.M.; Connor, J.; Ortega-Toro, E.; Torres-Luque, G. Intermonitor Variability of Garmin Vivofit® Jr. Wristband. *Appl. Sci.* **2024**, *14*, 3854. https://doi.org/10.3390/app14093854

Academic Editor: Jose Manuel Jimenez-Olmedo

Received: 11 March 2024
Revised: 18 April 2024
Accepted: 19 April 2024
Published: 30 April 2024

1. Introduction

Physical activity (PA) is widely acknowledged as an essential and fundamental component for achieving and maintaining optimal health and well-being, as numerous scientific investigations have conclusively shown. The benefits of regular PA extend beyond the physical realm and encompass mental health, and research has consistently demonstrated this [1]. PA, in general, is considered to be the most effective and beneficial when performed at moderate to vigorous intensity, consistently maintained over a prolonged period of time, without interruptions or pauses [2]. In light of the multiple health, wellness, and personal development benefits resulting from the practice of moderate-to-vigorous-intensity PA over an extended duration, a vast market of wearable, mobile, and technological devices have emerged, specifically designed and intended to monitor daily PA [3,4].

Arguably, it could be argued that among the instruments and devices used to measure and monitor PA, those that stand out for their precision and accuracy are accelerometers, which enable the direct and real-time recording of PA across a wide population over an extended period [5,6]. However, generating data and results from accelerometers generally involves highly complex, elaborate processing and treatment of information, as well as a significant financial investment, which limits and complicates their applicability, particularly for conducting research studies in the field of PA, health, and well-being [7,8].

Therefore, among the various consumer wearable activity devices available, activity wristbands have proven to be the most valued and utilized type of device by school-aged children [9,10].

For this reason, the attention of the scientific community in recent years has focused on validating and verifying wearable, mobile, and technological devices designed and intended to monitor PA, such as PA wristbands, which are characterized by being more comfortable, practical, and accessible, as well as more economical and affordable for conducting research in the area of PA [11,12].

Studies focusing on the validation of PA wristbands to measure PA primarily aim to evaluate and examine their accuracy, validity, and variability.

In this regard, there are several interesting points to highlight. On one hand, there are many brands of physical activity wristbands, the most analyzed in research in recent years for validation in school populations have been the Xiaomi Mi Band, Fitbit Charge or Ace, and Garmin Vivofit [9,10,13], where it has been observed that they are valid for estimating step volume [14,15]. Thus, there is evidence that these models are valid for estimating steps; however, there is little evidence of whether they are suitable for measuring the level of physical activity [16].

On the other hand, a very important aspect is the age at which this validity is demonstrated. Among the different models available on the market, only the Garmin Vivofit Jr. The PA wristband has been validated as a reliable and effective device for monitoring steps taken and minutes dedicated to moderate-to-vigorous-intensity physical activity (MVPA) in children aged 4 to 10 years [17] and has been used and applied in different research studies [18–20]. Regarding this specific model, previous studies in children aged 9 years and older indicate its validity for step measurement and portray it as an encouraging device for measuring physical activity at those ages [16,21].

Despite numerous studies utilizing the Garmin Vivofit® Jr. wristband to investigate PA, no research has specifically examined the reliability and variability among various units of the device during PA. The absence of detailed research on the coherence and consistency of data collected by multiple Garmin Vivofit® Jr. devices during PA constitutes a significant gap in the scientific literature on this topic. Thus, the primary objective of this study was to evaluate and validate the reliability and variability among different Garmin Vivofit® Jr. PA wristbands during PA periods, thereby providing a more comprehensive and detailed understanding of the accuracy and consistency of these devices in practical and research settings.

2. Materials and Methods

2.1. Study Design

This was an observational study to determine the agreement between six Garmin Vivofit® Jr. wristbands during a single session. The data were gathered from six devices simultaneously to examine the concordance among different devices and sides (three on each wrist). The study was approved by the ethics committee of the local institution (JUN.22/1.PRY).

2.2. Instrumentation

The instrument used in this study was the Garmin Vivofit® Jr. PA wristband (Garmin Ltd., Schaffhausen, Switzerland). These wristbands were specifically designed for children aged 4–9 years [17]. The screen size is 10×10 mm^2 ($0.39'' \times 0.39''$) with a screen resolution of 64×64 pixels, and its weight is 17.5 g. The wristband is water resistant. The water resistance of the wristband is up to a depth of 50 m. The battery life allows for one year of PA tracking, which is detailed in minutes of moderate-vigorous PA (MVPA), number of steps, and sleep quality (detection of movement during sleep) [22,23]. This wristband is intended for children and has considerable durability so that children may wear it anywhere, including during playtime, in water environments, or while sleeping. Features such as step measurement accuracy and battery life were important to ensure the reliability and consistency of the data collected during physical activities. The wristband is widely available on the market and accessible in terms of cost, making it easier to purchase multiple units for study. The Garmin Vivofit® Jr. wristband model is designed specifically for children, making it suitable for the target population of the study, which in this case was four-year-old children. The wristband fits comfortably on smaller wrists and is designed with features that are attractive and easy for children to use. The wristband has previously been used to accurately measure physical activity in children [17]. It is intuitive to use, requires minimal setup or maintenance, simplifies the data collection process, and improves the overall study experience. Parents can control the Vivofit Jr. activity tracker through the compatible Garmin Jr.TM mobile or tablet app on an iPhone or Android (Garmin International Inc., Olathe, KS, USA).

2.3. Procedure

Six Garmin Vivofit® Jr. wristbands were randomly selected from 24 wristbands, all less than two months old. All six wristbands were fitted simultaneously to the same subject (female, 4 years old, 20.2 kg, 110.3 m), who was physically active and had no physical limitations. The subject attended the laboratory during the morning. The wristbands were positioned in the wrist area, with three placed on the right arm and three on the left arm. To assess device reliability under laboratory conditions on a treadmill (Powerjog, model JM200, Sport Engineering Ltd., UK), the participant wore the six wristbands while performing five work conditions: sitting and standing (30 times per minute, controlled by a metronome), walking at 3 km/h, walking at 4 km/h, running at 5 km/h, and running at 6 km/h. Each situation was performed for eight consecutive minutes, where minutes one and six were eliminated, leaving the central six minutes with 10 min of rest between each condition. Throughout the six minutes, variables related to physical activity provided by the device, step count, and minutes of physical activity were recorded. To achieve this, all wristbands were synchronized to the device application via a mobile device (Garmin International Inc., Olathe, KS, USA), and results related to physical activity (step volume and minutes of physical activity) were logged via Bluetooth. This methodology was implemented in a manner similar to that used in other studies that used different types of devices [24–27].

2.4. Statistical Analysis

The parameters of the central tendency and dispersion are displayed throughout the mean [the CI of the mean assumes that sample means to follow a t-distribution with $N - 1$ degrees of freedom, a confidence interval for the mean of 95% (95% CI)], and a mean difference. The Kolmogorov-Smirnov test was computed to determine the normality of the data, resulting in a non-normal sample. The Intraclass Correlation Coefficient (ICC [absolute agreement, 2-way randomized, single measures, 95% CI]) was used to examine the correlation between the wristbands for measuring steps and minutes of PA. The cutoff values used to interpret the ICC were as follows: <0.5 = poor; 0.5 to 0.75 = moderate; 0.75 to 0.90 = good; and >0.90 = excellent reliability [28]. To appraise the level of concordance and identify systematic deviations between the two measurement instruments, Lin's concordance coefficient (CCC) was computed, according to Lin et al. [29]. The outcomes were stratified as follows: <0.9 (poor), 0.90–0.95 (moderate), 0.95–0.99 (substantial), and $\geq$0.99 (near perfect) [30]. Furthermore, a bivariate correlation analysis was conducted using Spearman's rank correlation coefficient (r_s), owing to the sample size and non-normal distribution [31]. Interpretation was delineated based on predefined thresholds: $\leq$0.1 (trivial), 0.1–0.3 (low), 0.3–0.5 (moderate), 0.5–0.7 (high), 0.7–0.9 (very high), and $\geq$0.9 (almost perfect) [32,33]. Passing and Bablok regression analysis [34] was employed to explore the existence of a linear association between paired observations from both instruments. This regression model, denoted as $y = ax + b$, facilitates the elucidation of the proportional discrepancies between the methods (parameter a, ideally 1) and systematic deviations (parameter b, ideally 0). Additionally, the standard error of the estimate (SEE) was computed. Diminished SEE values denote enhanced conformity of data points to the regression line, indicating reduced estimation error. The applicability of the Passing and Bablok regression was scrutinized using the Cusum test, where a p-value below 0.05 indicates the absence of a linear relationship between the wristbands. Bland-Altman plots, with their corresponding limits of agreement, were used to evaluate the concordance between the wristbands. The data from the wristbands were plotted against the average values of the paired devices, and the differences were compared. Additionally, the mean difference and the limits of agreement, which were calculated as the mean difference plus and minus 1.96 times the standard deviation of the differences, were plotted. The ICC was determined using IBM SPSS Statistics version 25.0 software for Windows (IBM Software Group, Chicago, IL, USA), while a spreadsheet called Jamovi 2.3.16, which is based on the graphical user interface R, was employed for the graphical representation of the Bland-Altman plots. The remaining statistical analyses were conducted using MedCalc Statistical Software version 20.100 (MedCalc Software Ltd., Ostend, Belgium).

3. Results

Table 1 shows the mean number of steps and minutes of PA for all wristbands.

Table 1. Mean (95% IC) for the variable's steps and minutes in MVPA measured by wristbands.

	Steps Mean (95% CI)	Minutes in MVPA Mean (95% CI)
Wristband 1	123.50 (100.29–146.70)	0.73 (0.57–0.90)
Wristband 2	127.80 (106.31–149.29)	0.77 (0.56–0.97)
Wristband 3	122.60 (99.99–145.20)	0.67 (0.45–0.88)
Wristband 4	124.10 (100.44–147.75)	0.80 (0.59–1.01)
Wristband 5	126.00 (102.84–149.16)	0.77 (0.57–0.96)
Wristband 6	129.27 (107.90–150.62)	0.77 (0.59–0.94)

Table 1 indicates that the highest mean values of the number of steps correspond to wristband 6, and the lowest to wristband 3; while for the variable minutes in MVPA, the highest corresponds to wristband 4, and the lowest to wristband 3.

In this line, the maximum average difference in steps for wristbands on the same side corresponds to wristband 2 with wristband 3, with this difference being close to 5 steps. Similarly, wristbands 2 and 3 show the maximum average difference in the comparison between the wristbands on the same side, with a difference of 0.20 min in MVPA. The mean values between body sides were similar for both variables.

Table 2 presents the mean difference, Spearman correlation coefficient, and Lin's concordance correlation coefficient for the variable's steps and minutes in MVPA for each wristband.

Table 2. Mean difference, Spearman's correlation coefficient (95% CI), and Lin's concordance correlation coefficient (95% CI) for both variables.

	Steps			Minutes in MVPA		
	Mean Diff	r_s	CCC	Mean Diff	r_s	CCC
Wristband 1 vs. 2	−4.30	1.000	0.993	−0.03	0.921	0.917
Wristband 1 vs. 3	0.90	1.000	0.996	0.07	0.973	0.888
Wristband 2 vs. 3	5.20	1.000	0.991	0.10	0.892	0.917
Wristband 4 vs. 5	−1.90	1.000	0.998	0.03	0.975	0.990
Wristband 4 vs. 6	−5.17	1.000	0.990	0.03	1.000	0.966
Wristband 5 vs. 6	−3.27	1.000	0.994	0.00	0.975	0.976

Note. Abbreviations; Mean Diff = difference between mean values, $r_{s\,=}$ Spearman's correlation coefficient, CCC = Lin's concordance correlation coefficient, % Cv = coefficients of variations express in percentage.

In Table 2, the coefficients of Spearman's correlation show a perfect correlation between wristbands in the variable's steps and an almost perfect correlation in all wristbands except in the association between wristbands 2 and 3 (very high correlation). Lin's concordance correlation coefficients indicate perfect concordance between Wristband 1 vs. 2, Wristband 1 vs. 3, Wristband 2 vs. 3, Wristband 4 vs. 5, and Wristband 5 vs. 6, only indicate a substantial concordance between Wristband 4 vs. 6 for the variable steps (Table 2). Following this line, substantial concordance was found between wrist bands 4 and 5, wrist bands 4 and 6, and wrist bands 5 and 6 in the variable minutes in MVPA. However, moderate concordance showed the coefficients between Wristband 1 vs. 2 and Wristband 2 vs. 3, and near moderate concordance for Wristband 1 vs. 3 in the variable minutes in MVPA. The results in Table 2 indicate that among wristbands worn on the same arm (non-dominant and dominant side), there are optimal correlation and concordance values for both steps and minutes in MVPA variables.

Table 3 shows the CCI values corresponding to the 95% CI between the wristbands.

Table 3. Intraclass Correlation Coefficient (Corresponding 95% Confidence Interval).

	Steps ICC (95%CI)	*p*	Minutes in MVPA ICC (95%CI)	*p*
Wristband 1 vs. Wristband 2	0.994 [a] (0.965–0.998)	<0.001	0.920 [a] (0.985–0.998)	<0.001
Wristband 1 vs. Wristband 3	0.997 [a] (0.994–0.999)	<0.001	0.892 [b] (0.786–0.947)	<0.001
Wristband 2 vs. Wristband 3	0.991 [a] (0.944–0.997)	<0.001	0.920 [a] (0.811–0.964)	<0.001
Wristband 4 vs. Wristband 5	0.998 [a] (0.995–0.999)	<0.001	0.990 [a] (0.975–0.996)	<0.001
Wristband 4 vs. Wristband 6	0.991 [a] (0.955–0.997)	<0.001	0.968 [a] (0.934–0.985)	<0.001
Wristband 5 vs. Wristband 6	0.994 [a] (0.983–0.998)	<0.001	0.977 [a] (0.952–0.989)	<0.001

[a] Excellent; [b] Good.

In Table 3, the measures of steps and minutes of PA between the wristbands showed good to excellent agreement based on the CCI values ($p < 0.001$). Consistent with previous correlation tests, the results continue along the same lines as those found in Table 2.

In Figures 1 and 2, Bland-Altman plots indicate the differences between the wristbands concerning the number of steps, and the limits of agreement can be seen.

Figures 1 and 2 show the differences between the wristbands and the limits of agreement of the wristbands concerning the steps. Systematic differences (mean differences) and the interval between the upper and lower limits of agreement are essential in determining the validity of the wristbands. The larger the interval between the upper and lower limits, the less accurate the measurements. All wristbands showed wide limits of agreement. In the step measurement, the graphs showed the narrowest limits for Wristband 4 vs. Wristband 5 (11.86 steps) and the widest limits for Wristband 4 vs. Wristband 5 (26.02 steps).

Figures 3 and 4 show the Bland-Altman plots indicating the differences between the wristbands concerning PA minutes and the limits of agreement.

Figures 3 and 4 show the differences between the wristbands and the limits of agreement of the wristbands concerning the minutes of PA. Systematic differences (mean differences) and the interval between the upper and lower limits of agreement are essential for determining the validity of the wristbands. The larger the interval between the upper and lower limits, the less accurate the measurements become. All wristbands showed wide limits of agreement. In the measurement of minutes of PA, the graphs showed the narrowest limits for Wristband 4 vs. Wristband 5 (0.27 min) and the widest limits for Wristband 1 vs. Wristband 3 (0.8 min).

Table 4 shows the Blan-Altman values with the upper and lower bias limits of agreement and 95% CI with upper and lower limits between wristbands concerning steps and minutes of MVPA.

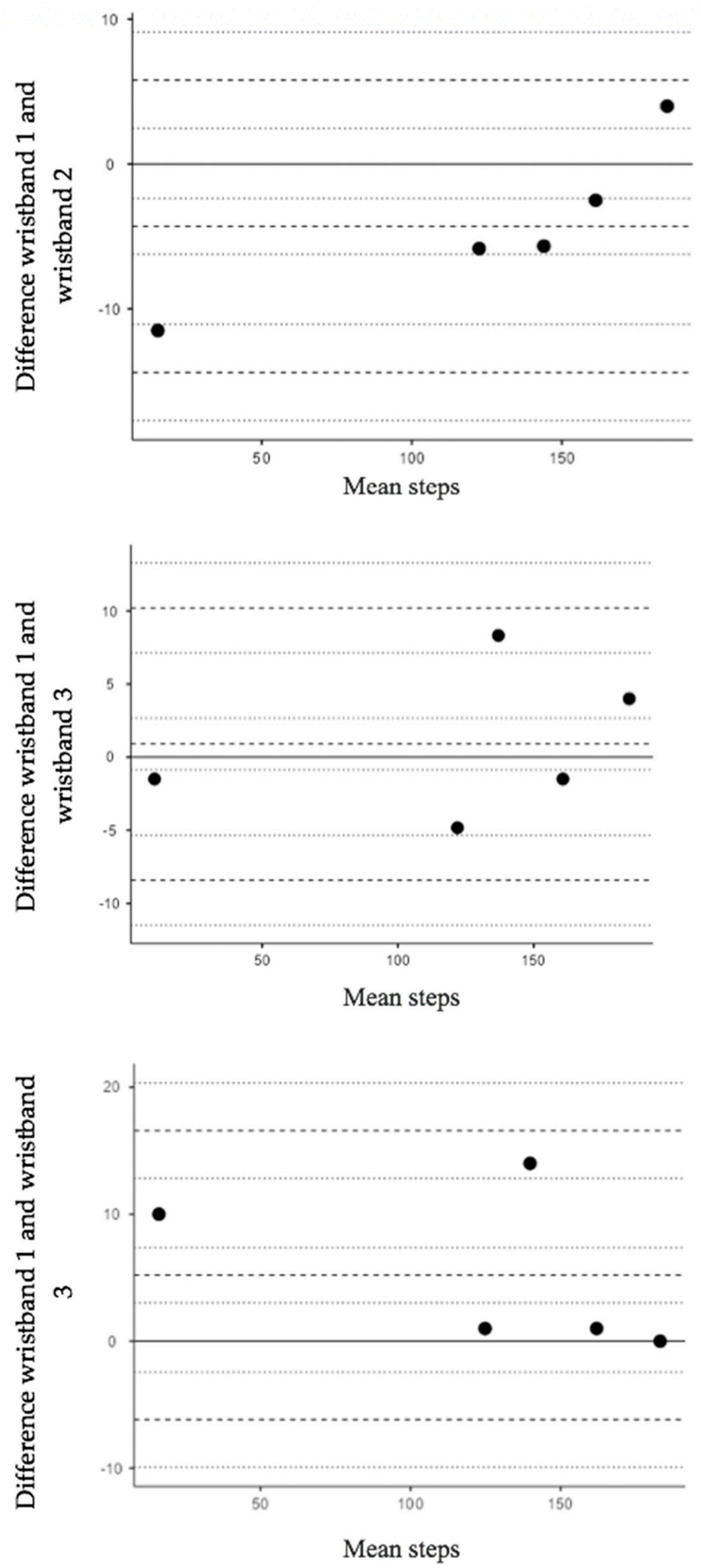

Figure 1. Bland-Altman plots of differences between right wristbands on steps. Straight line: Bias; dotted line: 95% LoA. Black dots highlight overlapping points.

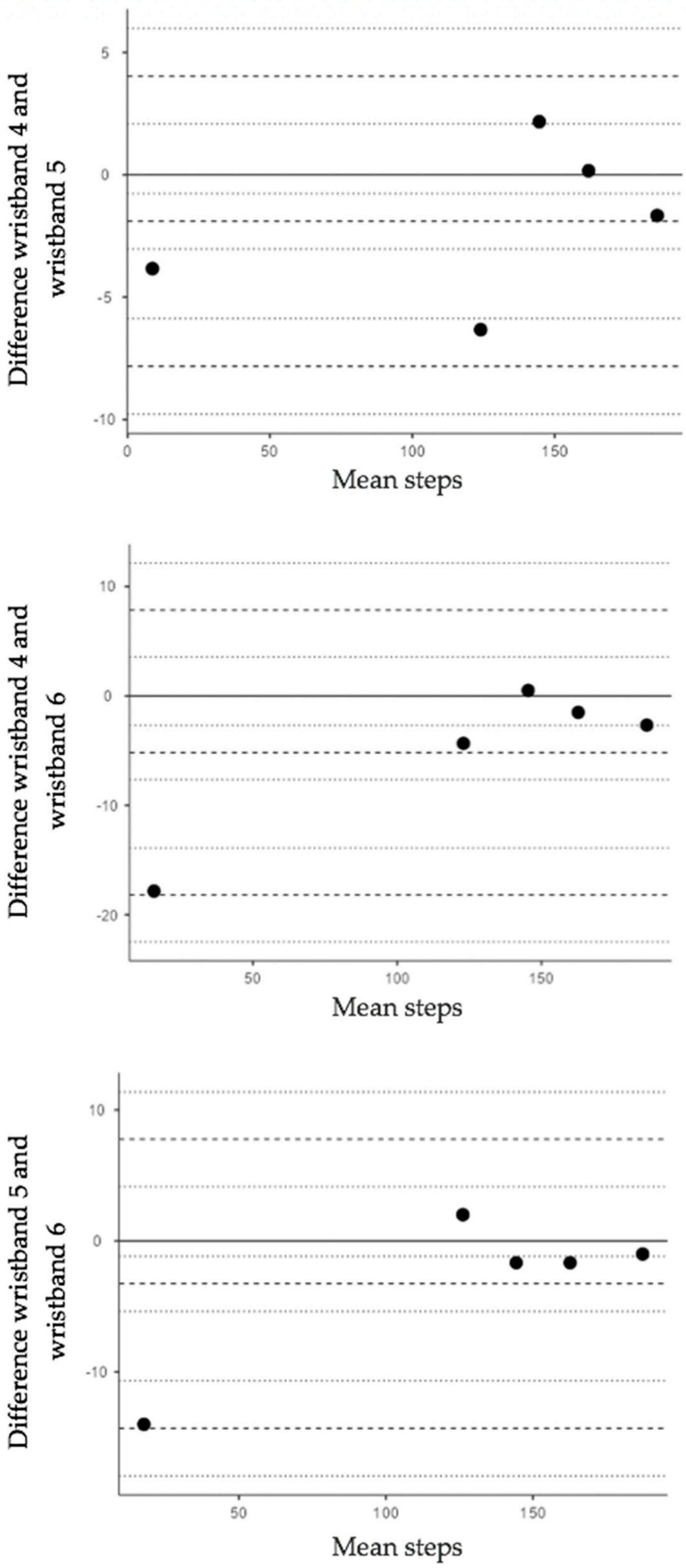

Figure 2. Bland-Altman plots of differences between left wristbands on steps. Straight line: Bias; dotted line: 95% LoA. Black dots highlight overlapping points.

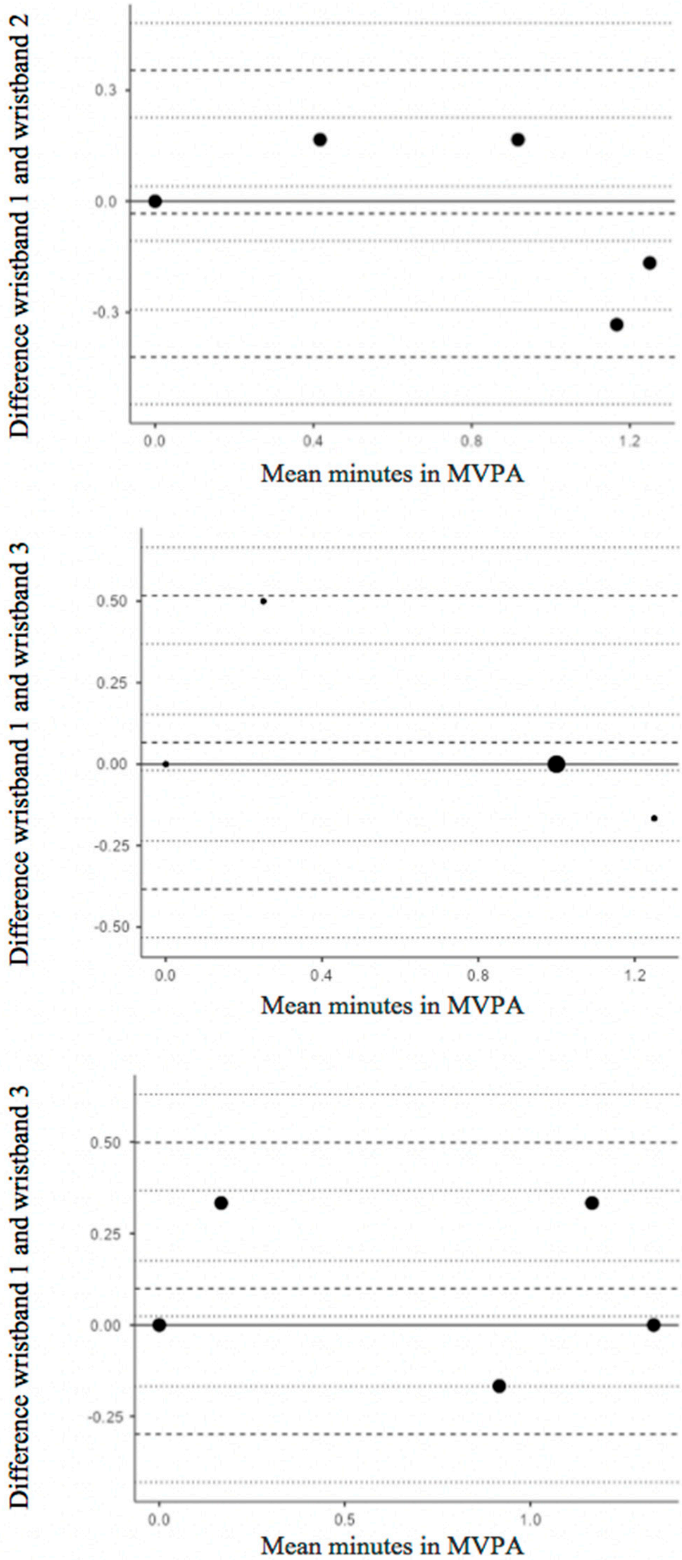

Figure 3. Bland-Altman plots of differences between right wristbands on minutes in MVPA. Straight line: Bias; dotted line: 95% LoA. Black dots highlight overlapping points.

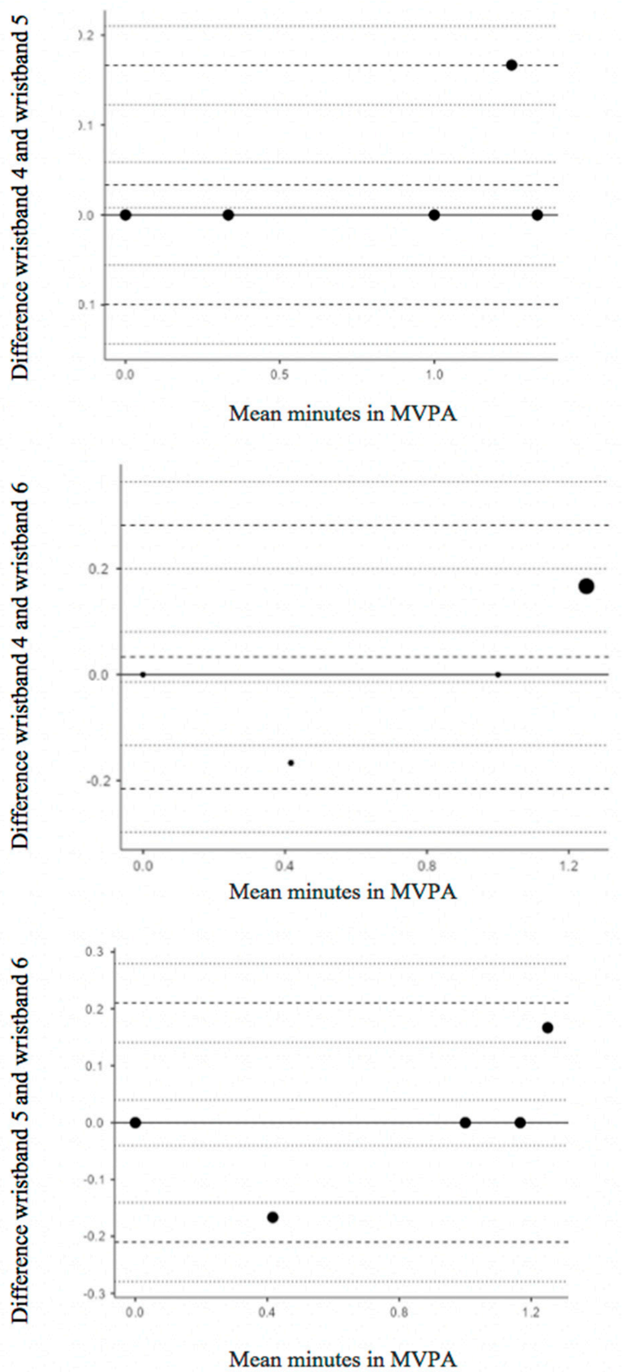

Figure 4. Bland-Altman plots of differences between left wristbands on minutes in MVPA. Straight line: Bias; dotted line: 95% LoA. Black dots highlight overlapping points.

Table 4. Blan-Altman 95% Limits of Agreement (LOA) and Bland-Altman 95% Confidence Interval (CI).

	LOA						95% CI			
	Steps			Minutes in MVPA			Steps		Minutes in MVPA	
	Bias	**Lower**	**Upper**	**Bias**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**
Wristband 1 vs. Wristband 2	−4.30	−14.39	5.79	−0.03	−0.42	0.35	−6.22	−2.38	−0.11	0.04
Wristband 1 vs. Wristband 3	0.90	−8.42	10.22	0.07	−0.038	0.52	−0.88	2.68	−0.02	0.15
Wristband 2 vs. Wristband 3	5.20	−6.18	16.58	0.10	−0.30	0.50	3.03	7.37	0.02	0.18
Wristband 4 vs. Wristband 5	−1.90	−7.83	4.03	0.03	−0.10	0.17	−3.03	−0.77	0.01	0.06
Wristband 4 vs. Wristband 6	−5.17	−18.18	7.84	0.03	−0.22	0.28	−7.65	−2.69	−0.01	0.08
Wristband 5 vs. Wristband 6	−3.27	−14.30	7.77	0.00	−0.21	0.21	−5.37	−1.16	−0.04	0.04

The step measurement in Table 4 shows the narrowest limits for Wristband 4 vs. Wristband 5 (11.86 steps) and the widest limits for Wristband 4 vs. Wristband 5 (26.02 steps). In the measurement of minutes of PA, the table showed the narrowest limits for Wristband 4 vs. Wristband 5 (0.27 min) and the widest limits for Wristband 1 vs. Wristband 3 (0.8 min). The results from the Bland-Altman analysis show errors not exceeding 6 steps and not exceeding 0.11 min in MVPA.

Moreover, Passing and Bablok regression analysis is displayed in Figure 5 for steps performed and time spent in MVPA in Figure 6.

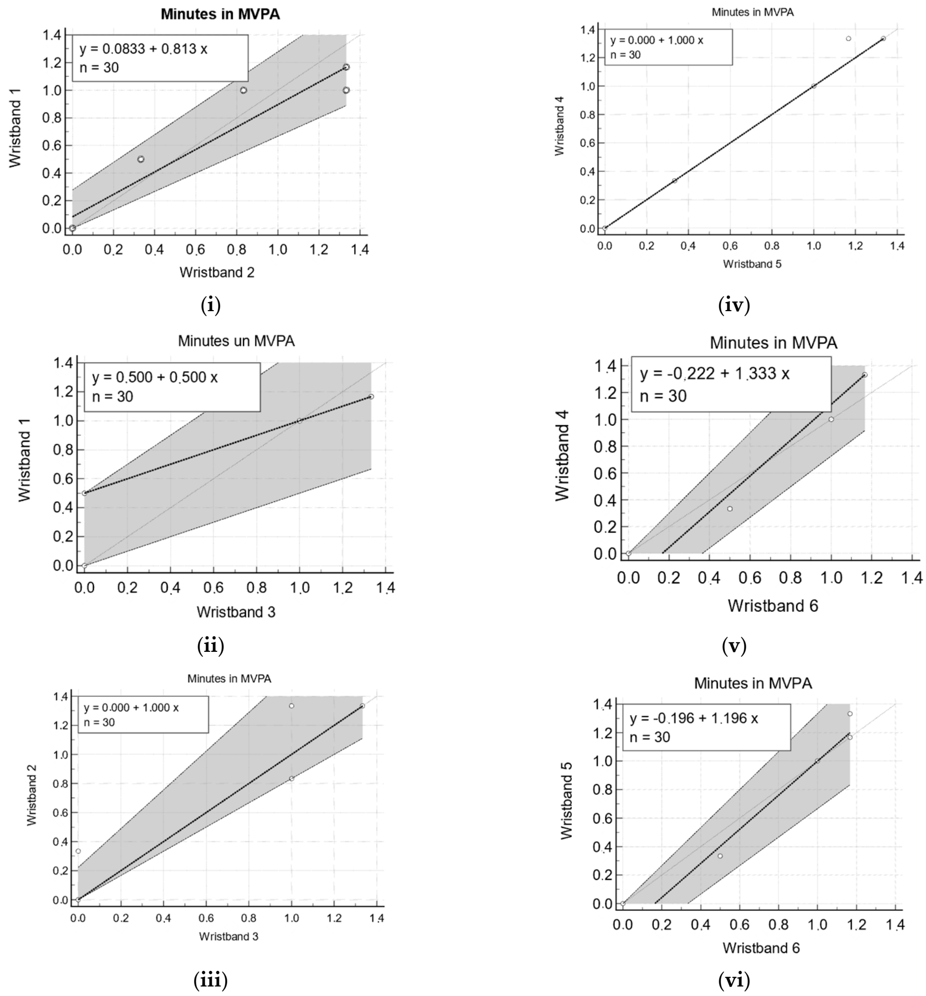

Figure 5. Scatterplot between wrist bands using Passing and Bablok regression for the variable minutes in MVPA: (**i**) wristband 1 vs. 2; (**ii**) wristband 1 vs. 3; (**iii**) wristband 2 vs. 3; (**iv**) wristband 4 vs. 5; (**v**) wristband 4 vs. 6; (**vi**) wristband 5 vs. 6. The black line represents the regression line, the shaded area is the confidence interval for 95% of the regression line, and the discontinuous grey line is the perfect regression line.

Figure 5 displays a robust linear association among wristbands for the variable minutes in MVPA, where their slopes are close to the intercept in all associations and are close to unity. No systematic differences were found between the wristband intercepts; the large intercept corresponds to wristbands 1 and 3, with values close to half a minute. Hence, the precision and systematic errors among the wristbands were similar. Likewise, the regression model indicates an optimal fit of the data since the maximum SEE funded was 0.21 (wristbands 1 and 3). In addition, linear model validity via the Cusum test showed no significant deviation from linearity, except for the association between wristbands 1 and 3 ($p < 0.010$) and wristbands 4 and 6 ($p < 0.010$).

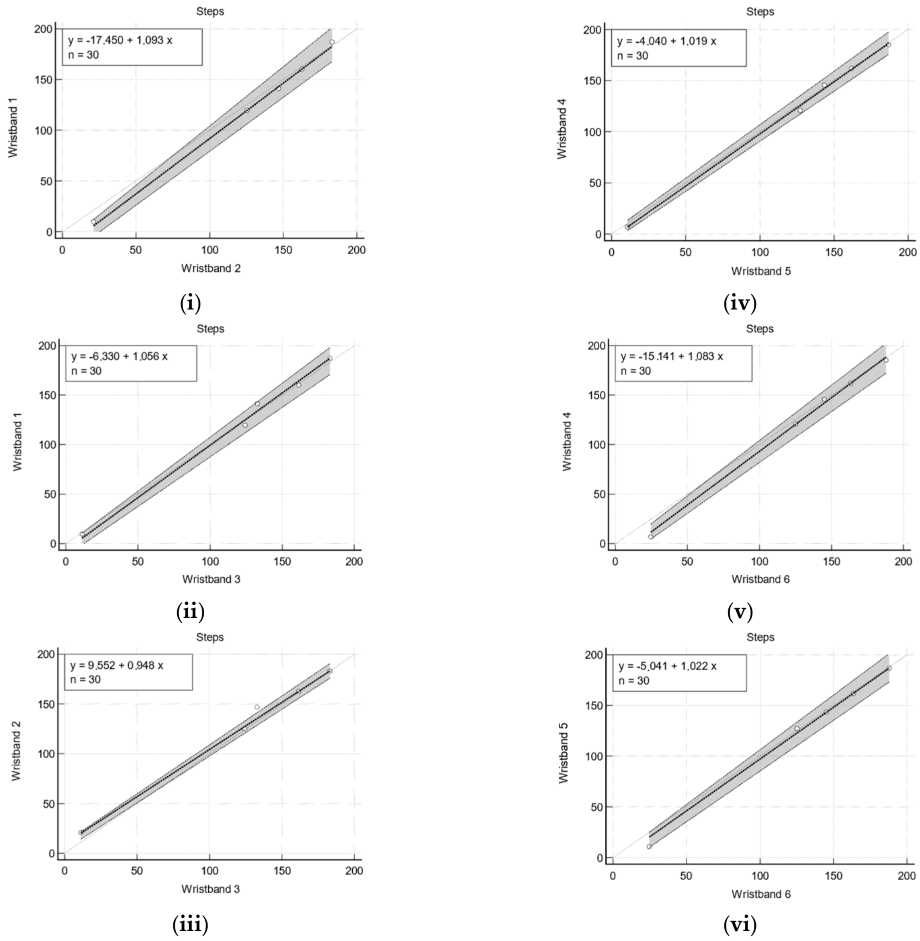

Figure 6. Scatterplot between wristbands using Passing and Bablok regression for the variable steps: (**i**) wristband 1 vs. 2; (**ii**) wristband 1 vs. 3; (**iii**) wristband 2 vs. 3; (**iv**) wristband 4 vs. 5; (**v**) wristband 4 vs. 6; and (**vi**) wristband 5 vs. 6. The black line represents the regression line, the shaded area is the confidence interval for 95% of the regression line, and the discontinuous gray line is the perfect regression line.

Passing and Bablok regression analysis displayed in Figure 6 for the variable steps were optimal for both the systematic differences [maximum value of intercept = 17.45 steps (wristbands 1 and 2)] and proportional differences (slopes very close to the unit). The fit of the data was calculated through SEE (maximum value = 3.90); therefore, random differences were controlled. Finally, the critical alpha value of the Cusum test was highest at 0.050 for all wristband associations.

4. Discussion

This study investigated the intraclass reliability between Garmin Vivofit® Jr. wristbands for determining the number of steps and minutes of PA in situations that may reflect everyday life situations in children. The Garmin Vivofit Jr. wristbands are specific for children aged 4–10 years [17,35], compared to a very high volume of PA wristbands of different brands that are tailored to the adult population [36,37]. It is therefore critical to undertake this analysis to determine the robustness of measuring PA in children using these devices, as the variability between monitors needs to be minimal to allow adequate between-subject and within-subject comparisons [24]. Thus, the most important finding of this study is that the wristbands show good intraclass reliability for ordering steps and minutes of PA, and are suitable for field-based research.

It was not possible to compare overestimates or underestimates with the previous literature because of the lack of other studies evaluating the reliability or validity of this specific model of wristbands, although some studies have performed intra-device validation, as in the case of accelerometry [24,25]. It is interesting to highlight that, regarding PA, this wristband measures steps and minutes of MVPA, with encouraging data regarding its reliable measurement for young children [16,17]; although technical details and manufacturers' algorithms are sometimes kept confidential [9,17]. However, to our knowledge, this is the first study to evaluate intra-device variability in a wristband intended for children, a truly useful aspect when this device is being applied in a school setting and other environments where different participants are simultaneously engaged [18,19].

Thus, in the intra-device study, the evaluated wristbands showed a very small overestimation of the number of steps between Wristband 1 and Wristband 3 (1%) and between Wristband 2 and Wristband 3 (4%). The closest existing data in the literature refers to the Garmin Vivofit model, which, in activities typical of daily life throughout the day, offered this overestimation at 12% [13]. However, our results are in agreement with those of another study in which the Fitbit Flex wristband was used throughout the day (3%) [38], whereas in other wristbands, such as the Polar Loop, a wide range of 8.9 and 28% was used [37]. Therefore, the possible estimation in this study was shown to be between only 1 and 4% compared to other wristbands that do so in a range between 11 and 37%, such as the Fitbit (21%), Huawei (19%), Asus (11%), and Polar (37%) [39]. Regarding the underestimation of step count, the percentages of variability were between 2 and 4% (between wristband 1 and wristband 2 (3%), wristband 4 and wristband 5 (2%), wristband 4 and wristband 6 (4%), and wristband 5 and wristband 6 (3%). Although there are no specific data with a model in the literature, these low values are in agreement with other models of the same gait that have assessed PA in daily life conditions, with similar values between 4 and 5% underestimation (Garmin Vivofit and Garmin Vivofit 1 (4%), Garmin Vivofit 3 (5%) [37,40].

These data highlight those studies assessing step volume in early-age children using the Garmin Vivofit Jr. model are methodologically reliable. Moreover, these are essential data since the recommendations for daily step volume are approximately 10,000 steps in the adolescent and adult population [41], while these values increase to 13,000 steps in the case of younger ages [42,43]. Being able to have a wristband that reliably measures the volume of steps at these ages may contribute to the greater use and promotion of PA, as has been previously reported in different studies [17,18].

Another beneficial value of the Garmin Vivofit Jr. wristband is the quantification of the PA volume. In this regard, the results obtained for minutes engaged in PA were also reliable. In terms of overestimation, percentages were observed between Wristband 1 and Wristband 3 (4%), between Wristband 2 and Wristband 3 (10%), between Wristband 4 and Wristband 5 (4%), and between Wristband 4 and Wristband 6 (4%). These values are lower than those found in similar wristbands and free-living conditions, such as Fitbit (20%), Huawei (13%), and Polar (57%) [39]. Analyzing the validity of these wristbands is crucial when considering purchasing, as there are models such as the Fitbit Ace 2 that have not demonstrated validity for steps and minutes of PA in children in the scientific literature [16]. Regarding the possible underestimation in PA minutes, it is worth noting that the difference between Wristband 1 and Wristband 2 was 4%, while there are no notable differences among the rest. These results are similar to those found in another study under free-living conditions for 15 min using Asu's b wristband (2%) [39]. In a recent study, it was indicated, in a comparison in children aged nine and above, that the Garmin Vivofit Jr. is suitable for measuring steps and minutes of physical activity [16], so not only knowing that this is the case but also if we use several devices at the same time, they will measure what they are supposed to measure, opening up opportunities in different environments. In fact, measurements are reliably taken intra-device and can provide information on whether healthy PA recommendations are met by the World Health Organization or other institutions at young ages [44,45].

The present study highlights the validity and intra-device reliability both in the volume of steps and minutes of PA, with percentages ranging between 1 and 4% in steps and 2% and 4% in minutes of PA. This suggests that this wristband demonstrates good reliability, with fluctuations below those admitted in other wristbands with the same purpose [37,39], and is suitable for use in the child population. However, this study has several limitations. This study was conducted in a laboratory setting, which, methodologically, is a controlled environment. Some studies have indicated that some wristbands, similar to those evaluated, are more unstable when there are activities such as climbing stairs [46] or applying them in free-living conditions [47], an aspect that could be investigated in the future. Another important limitation of this study was related to the duration of the activities performed. Although various types of physical activities were included, according to the different situations of physical activity in a child, the duration of each activity was to six minutes, by the participant's profile. A possible improvement in the future would be to repeat the study on different days and at different times of the day to assess the consistency of results over time. This would allow confirmation of whether the physical activity measurements reliably obtained by the wristbands remain consistent under different conditions and contexts.

Nevertheless, these findings have great practical applications since, on the one hand, portable technology is increasingly used to assess PA, as its attractive design and easy use make it practical for consumers [48,49]. Admittedly, most studies were older [50,51]. In the case of the Garmin Vivofit Jr., it has previously been shown that the child population has shown a liking for wearing the wristband without having problems with design, which makes this tool very useful for long-term use [13]. With this study knowing that intra-device validity is suitable for PA measurement, apart from the fact that this type of activity monitor is the most plausible for use in terms of health [52], these results represent an essential breakthrough in the employment of PA assessment and promotion in children. The success of physical activity wristbands worldwide is justified by their price. Although there are various studies that utilize different wristbands based on their higher or lower price [16,53], in the case of the Garmin vivofit jr., in addition to being rated as having a medium price, it is the only one that indicates it is specifically designed for children, thus giving it unique characteristics

In the current market, fitness activity wristbands designed specifically for children are less common compared to those aimed at adults. Most of the available wristbands are designed to fit the wrists and needs of adults, which may not be suitable or comfortable for young children. It is considered that this is a strength of the present study. Physical activity wristbands for children should be tailored to their unique needs, including wrist size, durability, and ability to interact in an engaging way with the child. Models designed for adults may not meet these requirements, limiting their applicability and effectiveness in the context of a study with young children.

This research not only presents established findings but also opens up new avenues for future investigations. It would be intriguing to explore the effects of prolonged use of PA wristbands on children's physical activity behavior and habits over time. Moreover, these wristbands can be used to examine the influence of factors such as weather, social environment, and individual preferences on physical activity behavior. Longitudinal studies may provide valuable insights into the long-term impact of these wristbands on behavior and health.

This study's findings have the potential to significantly impact the promotion of children's health and the prevention of lifestyle-related diseases in practical application. For example, schools and educational programs could consider incorporating Garmin Vivofit Jr. wristbands into curricular activities to encourage physical activity among students. In addition, educators can use Garmin Vivofit® Jr. wristbands to monitor students' PA levels before and after the implementation of an active recess program or enhanced physical education classes. Parents and caregivers can use physical activity wristbands as a motivational tool to encourage active lifestyle habits in children. For example, they can set goals for daily steps or minutes of physical activity and use the data provided by wristbands to track progress and reward achievement. Garmin Vivofit® Jr. wristbands can also be used as part of strategies to limit screen time for children. For example, parents can set time limits for electronic device use and use wristbands to encourage children to participate in alternative physical activities when they reach those limits. In addition to measuring PA, activity wristbands can provide information about sedentary behavior in children, such as time spent sitting or being inactive. This information can prove beneficial for comprehending the sedentary behavior patterns of children and devising strategies to mitigate them, such as incorporating active pauses during study sessions or classwork. This study demonstrates the validity of wristband validation, thereby ensuring the reliability of its utilization. Additionally, healthcare professionals can use these devices as assessment and monitoring tools in clinical settings to manage and prevent health issues related to physical inactivity. Overall, this study provides a solid foundation for future research and highlights the potential of Garmin Vivofit Jr. wristbands as a valuable tool for promoting physical activity and health in the pediatric population.

5. Conclusions

The analysis of the reliability and intra-device variability of Garmin Vivofit Jr. wristbands in measuring PA in children confirms their utility as a precise and reliable tool for assessing PA levels in this population. This finding underscores the importance of having reliable and accessible monitoring devices to promote more active lifestyles from childhood, which can have a significant impact on long-term health.

Furthermore, Garmin Vivofit Jr. could be used during physical promotion programs to provide accurate feedback to preschool to ensure their accomplishment with the physical activity recommendations.

Author Contributions: Conceptualization, G.T.-L. and J.C.; Methodology, G.D.-Q. and J.M.G.-E.; Software, E.O.-T. and J.M.G.-E.; Validation, G.D.-Q. and J.M.G.-E.; Formal Analysis, J.C. and E.O.-T.; Investigation, E.O.-T., G.D.-Q. and G.T.-L.; Resources, E.O.-T. and G.T.-L.; Data Curation, G.D.-Q. and J.M.G.-E.; Writing—Original Draft Preparation, G.D.-Q., J.M.G.-E. and G.T.-L.; Writing—Review & Editing, G.D.-Q., J.M.G.-E. and J.C.; Visualization, E.O.-T. and G.D.-Q.; Supervision, J.C. and G.T.-L. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Ethics Committee of the local institution (University of Jaén, Spain [JUN.17/6]).

Informed Consent Statement: Informed consent was obtained from all the subjects involved in the study.

Data Availability Statement: The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

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