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Use of a smartwatch for home blood pressure measurement

Uso de un reloj inteligente para la medición doméstica de la presión arterial

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Abstract

The use of smart watches represents an advantage in home monitoring of ambulatory patient blood pressure; but it is necessary to know the degree of correspondence with the conventional equipment for a better control of the blood pressure that is of clinical utility, in the present study the correlation of the values of the blood pressure obtained by a digital baumanometer and by a watch was evaluated. intelligent in young males at rest and after exercise; the results obtained show a good correlation between the measurements obtained by both teams (R2 values greater than 0.7), the cautious use of smart watches is useful for better monitoring of blood pressure and presents advantages such as automatic and digital recording of the values that can be used for ambulatory blood pressure monitoring.

Environmental monitoring, Baumanometer, Blood pressure

Resumen

El uso de relojes inteligentes representa una ventaja en el monitoreo doméstico de la presión arterial de pacientes ambulatorios; pero se precisa conocer el grado de correspondencia con los equipos convencionales para una mejor control de la presión arterial que sea de utilidad clínica, en el presente estudio se evalúo la correlación de los valores de la presión arterial obtenidos por un baumanómetro digital y por un reloj inteligente en varones jóvenes durante el reposo y posterior al ejercicio; los resultados obtenidos muestran una buena correlación entre las medidas obtenidas por ambos equipos (valores de R2 superior a 0.7), el uso cauteloso de relojes inteligentes es útil para un mejor monitoreo de la presión arterial y presenta ventajas como el registro automático y digital de los valores que pueden emplearse para un monitoreo ambulatorio de la presión arterial.

Monitoreo ambiental, Baumanómetro, Presión arterial

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Introduction

The reliable measurement of blood pressure is important because it allows the correct classification of a patient's risk; although this procedure may seem simple, it can lead to complications such as errors in the reading by the personnel performing the measurement, who must be trained and qualified in the use and handling of the device and use a reliable and valid apparatus. In this sense, the device considered the gold standard is the mercury sphygmomanometer; but these devices have the disadvantage that they are currently in disuse due to the risk to environmental health and are being replaced by digital devices such as digital manometers and smart watches1-4.

Therefore, it is inferred that the alternatives for measuring blood pressure must be calibrated periodically and comply with a minimum of pre-established clinical criteria to avoid erroneous or non-validated data; With the rise of smart watches that incorporate cardiovascular measurement systems such as pulsimeters, oximeters and baumanometers, they can be included as auxiliary tools in the monitoring of blood pressure in ambulatory patients to obtain blood pressure records throughout the day, as they are easily connected to mobile phones that record this data and present it in a simple graphic form2,3,5-7. The aim of the present study was to evaluate the correlation of existing blood pressure measurements between those obtained by a digital blood pressure monitor and a smart watch, in order to determine the usefulness of using these devices in a compensatory and practical way in patients of working age and with social commitments that would prevent them from adequately controlling their health and carrying out a more effective therapeutic follow-up.

Methodology

A descriptive cross-sectional study was conducted in which volunteer participants who filled out the informed consent form were registered and asked to complete a standardised and validated digital questionnaire (eHEALS) that measures a patient's basic digital health literacy8.

During the measurement, a trained research assistant performed the blood pressure measurements using the digital baumanometer and by placing the smartwatch with blood pressure monitor on the wrist and recorded the blood pressure readings. Blood pressure was taken from the left arm or wrist while the subject remained seated, without talking, without crossing the legs and resting the arm on a flat surface at the level of the heart; it was measured initially in a resting state9, after the initial interview we waited 10 minutes for the patient to relax, then asked the patient to walk up and down 60 steps of 15 cm each, and after 5 minutes blood pressure was measured again with both devices.

The demographic characteristics of the study cohort are: 26 young Latino males aged 20-23 years with no history of chronic diseases such as diabetes or hypertension, normal height, weight and body mass index (between 20 and 22), non-smokers and non-caffeine users; The blood pressure data were processed in Excel® and box and whisker plots were obtained for all values obtained and linear regression analysis was performed to measure the correspondence of the data from the digital baumanometer and the smart watch, from which the equation of the line and the correlation coefficient, R, were obtained.

Results and discussion

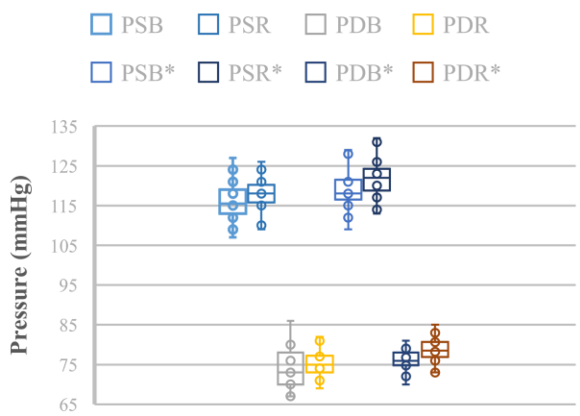
In this study it was decided to include only normotensive males to rule out any interference of the disease or antihypertensive pharmacotherapy in the results, although the aim of this work was to compare the measurements made by a smart watch with those obtained with a conventional digital blood pressure monitor commonly used in clinical practice, women were not included because the exact effect of the menstrual cycle on blood pressure during physical activity or exercise is not known9.

The blood pressure values obtained from the measurements of the young volunteers are reported in table 1 and figure 1, these values are consistent with those reported for healthy, non-hypertensive young people as optimal blood pressure is considered to be <120 mmHg for systolic and <80 mmHg for diastolic and normal <130 mmHg and <85 mmHg, respectively10,11.

Although frequent exercise has a hypotensive effect in hypertensive patients due to different mechanisms such as decreased peripheral vascular resistance, decreased plasma renin activity, reduced body weight and body fat, among others, it tends to increase slightly immediately after physical activity and normalises and decreases from baseline; In this study we did not inquire about their physical activity habits that would influence post-exercise blood pressure, since an individual accustomed to practising some physical activity tends to lower their blood pressure due to better breathing control and a more adequate cardiovascular response9,12-15.

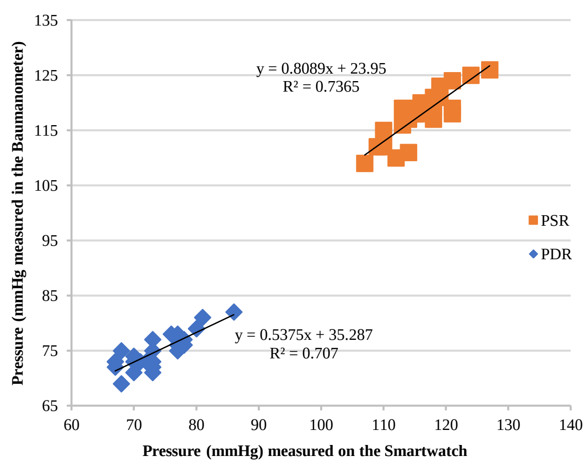
	PSB	PSR	PDB	PDR	PSB*	PSR*	PDB*	PDR*
MIN	107	109	67	69	109	113	70	73
Q1	113	116	70	73	117	119	75	77
Q2	116	118	73	75	118	122	76	79
Q3	119	120	77	77	122	124	78	81
MAX	127	126	86	82	129	132	81	85
X	116	118	74	75	119	122	76	79
DE	5	4	5	3	5	5	3	3

Table 1 Pressure values obtained in healthy male volunteers (n=26) measured at rest and after moderate exercise (the first 2 letters denote Systolic Pressure, SP, or Diastolic Pressure, DP, the last letter denotes the measuring device, B is bathometer and R is electronic clock, post-exercise status is denoted by *; Min group minimum value, Max group maximum value, X mean, SD standard deviation, Q quartile, X-quartile.)
Source: Own elaboration with the results of the research



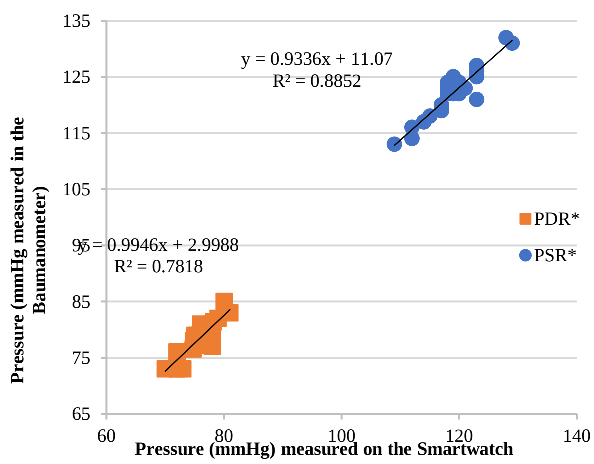
Graphic 1 Distribution of pressure values obtained in healthy male volunteers (n=26) measured at rest and after moderate exercise (the first 2 letters denote Systolic pressure, SP, or Diastolic pressure, DP, the last letter denotes the measuring device, B is bathometer and R is electronic clock, the post-exercise state is denoted by *, the last letter denotes the measuring device, B is bathometer and R is electronic clock, the post-exercise state is denoted by *)
Source: Own elaboration with the results of the research

The correspondence of the blood pressure measurements at rest (figure 2) was acceptable, a better correlation was obtained between the data obtained in both instruments in the systolic pressure (R2=0.7365) with respect to the correlation in the diastolic pressure (R2=0.707), as it was observed that the smart watch was more accurate at higher values of pressure; the same was observed in the values of blood pressure after exercise as the R2 values in this case were 0. 7818 for diastolic and 0.8852 for systolic, corroborating the assertion that the smartwatch is less sensitive than the blood pressure cuff and requires a higher pressure value to obtain a similar reading; this is of great clinical importance because accurate pressure measurement is a critically important characteristic as an error in pressure reading of more than five millimetres of mercury can lead to misclassification of the patient. In addition to the measuring equipment, one of the factors that most influences the recording of blood pressure is the analyst, which is why he or she must be trained initially and periodically. In this study, a single analyst participated who was trained to take all the measurements in order to rule out variation due to different analysts; it should be noted that the existence of technical errors in taking blood pressure is not mutually exclusive, but rather their effects are additive6,16.



Graphic 2 Correlation of pressure values obtained in healthy male volunteers (n=26) measured during the resting state (PSR resting systolic pressure, PDR resting diastolic pressure, PDR resting diastolic pressure, PDR resting diastolic pressure, PDR resting systolic pressure, PDR resting diastolic pressure, PDR resting diastolic pressure, PDR resting diastolic pressure)
Source: Own elaboration with the results of the research

The importance of knowing the correlation of blood pressure values obtained by two instruments, one frequently used and the other recently introduced, is to know the reliability of the measurements made by the latter and to be able to use it in environmental blood pressure monitoring (ABPM) because it has the advantage of being portable or wearable, which allows blood pressure to be recorded periodically during the daily routine; in addition to this, smart watches can be attached to mobile phones and the pressure is recorded in their own application for subsequent analysis3,7,17-19.

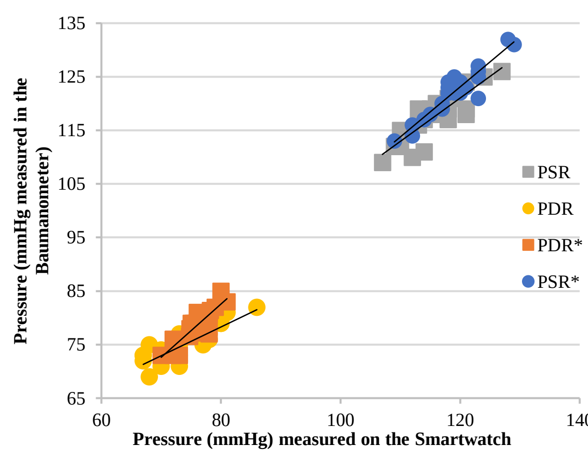


Graphic 3 Correlation of blood pressure values obtained in healthy male volunteers (n=26) measured during the post-exercise state (PSR* post-exercise systolic pressure, PDR* post-exercise diastolic pressure, PDR* post-exercise diastolic pressure, PSR* post-exercise systolic pressure, PDR* post-exercise diastolic pressure, PDR* post-exercise diastolic pressure)
Source: Own elaboration with the results of the research

Similarly, the values of the slope (m) and the intersection of the ordinate (b) in the equation of the line obtained in each case describe an increase in correspondence and sensitivity with increasing blood pressure; this is best seen in figure 4, where the pressure values at the two times, at rest and after exercise, are compared. This is consistent with the results found by Falter et al. (2022), in their study they found a systematic bias that overestimated low readings and underestimated high readings; they also stress the importance of creating standards for these reading devices for clinical use, a substantial difference with this study is that the volunteers participated in the measurement and were medicated hypertensives18.

In general, studies agree with this work on the accuracy of smartwatches in controlled conditions, as Kario et al. (2020) found that office-based measurement (as in this paper) was more accurate than ambulatory measurement; However, it should be used with caution and the device should be properly calibrated; this represents an opportunity for improvement to establish criteria for its use and to take advantage of the advantages it offers, especially in ABPM, such as its use in patients with chronic diseases, and to bear in mind that each smartwatch has its own characteristics of the manufacturer and will also depend on its generation, as this device (gadget) becomes more popular it will surely obtain improvements in its design that will allow it to increase its accuracy17-22.

In the same vein, although blood pressure monitoring using a calibrated smartwatch is feasible for domestic and ambulatory measurements, precautions should be taken regarding its use in the real world environment such as at home and in the office and technical specifications such as optimal recalibration time, training for proper use and data acquisition should be taken into account; it should also be noted that good support in pharmaceutical care would help to solve many of these problems and promote pressure control and therapeutic adherence 20-24.



Graphic 4 Correspondence of pressure values obtained in healthy male volunteers (n=26) measured at rest and after moderate exercise (the first 2 letters denote systolic pressure, SP, or diastolic pressure, DP, the last letter denotes the measuring device, B is bathometer and R is electronic clock, the post-exercise state is denoted with *)
Source: Own elaboration with the results of the research

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Conclusions

The blood pressure values of young men, at rest and after exercise, measured with the smart watch correlate well with those obtained with the digital bathometer; it was observed that this correlation improves when a higher blood pressure value is recorded, suggesting a lower measurement sensitivity in the digital watch; the measuring instruments should be calibrated to adjust their values and allow a reliable measurement that allows adequate monitoring of the patient's pressure and provides useful data in clinical and pharmaceutical follow-up.

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