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Smartwatches and measurement of physical activity, sedentary behavior, and sleep: a scoping review

Smartwatches e medidas de atividade física, comportamento sedentário e sono: uma revisão de escopo

AUTHORS

José Francisco da Silva[1]
Antonio Henrique Germano-Soares[2]
Luis Carlos Barbosa Silva[1]
Valter Cordeiro Barbosa Filho[3]
Tuillamys Virgínio de Oliveira[1, 2]
Thiago Coelho de Aguiar Silva[4]
Rafael Miranda Tassitano[5]

1 Universidade de Pernambuco, Programa de Pós-graduação em Educação Física, Recife, Pernambuco, Brasil.
2 Faculdade Pernambucana de Saúde, Departamento de Educação Física, Recife, Pernambuco, Brasil.
3 Universidade Estadual do Ceará, Programa de Pós-graduação em Saúde Coletiva, Fortaleza, Ceará Brasil.
4 Universidade de Pernambuco, Departamento de Educação Física, Recife, Pernambuco, Brasil.
5University of Illinois Urbana-Champaign. College of Applied Health Sciences, Department of Health and Kinesiology, Illinois, United States

CORRESPONDING

1206 South Fourth Room 3007A Huff Hall | M/C 052. Champaign, Illinois, United States Zip code 61820

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ABSTRACT

Introduction: The use of accelerometers to measure physical activity (PA), sedentary behavior (SB), and sleep has significantly impacted public health, though limitations such as storage capacity and cost persist. Smartwatches have emerged as promising alternatives, providing objective measurements and real-time data extraction. Despite their growing popularity, there is still a lack of comprehensive information on smartwatch models, sensors, and data transfer methods. **Objective:** To map the technical characteristics related to sensors, metrics and type of data transfer of different models of smartwatches capable of measuring PA, SB and sleep. **Methods:** The review utilized the Joanna Briggs Institute guidelines and included 143 smartwatch models from 12 manufacturers. **Results**: All models measured PA, step counts, and daily calories, while the SB metric was present in 35.5% of the smartwatches, sleep duration in 93.1%, and 35.5% of smartwatches measured PA, SB and sleep simultaneously. The most common smartwatches sensors were photoplethysmography, geolocation and gyroscope. All models were found to have Bluetooth connectivity, with 55% of the models featuring Wi-Fi connectivity, and only 11.3% of smartwatches having a mobile network. **Conclusion:** This scoping review can guide studies, interventions, and healthcare professionals, as well as assist end-users to select an appropriate smartwatch for measure PA, SB, and sleep.

Scoping review registration: https://osf.io/3s9x5

Keywords: Fitness trackers; Wearable electronic devices; Physical activity; Sedentary behavior; Sleep.

RESUMO

Introdução: O uso de acelerômetros para medir atividade física (AF), comportamento sedentário (CS) e sono impactou significativamente a saúde pública, embora limitações como capacidade de armazenamento e custo persistam. *Smartwatches* emergiram como alternativas promissoras, fornecendo medições objetivas e extração de dados em tempo real. Apesar de sua crescente popularidade, ainda há uma falta de informações abrangentes sobre os modelos de *smartwatches*, sensores e métodos de transferência de dados. **Objetivo:** Mapear as características técnicas relacionadas aos sensores, métricas e tipo de transferência de dados de diferentes modelos de *smartwatches* capazes de medir AF, CS e sono. **Métodos:** Esta revisão utilizou as diretrizes do Instituto Joanna Briggs e incluiu 143 modelos de *smartwatches* de 12 fabricantes. **Resultados:** Todos os modelos mediram AF, contagem de passos e calorias diárias, enquanto a métrica de CS estava presente em 35,5% dos *smartwatches*, a duração do sono em 93,1%, e 35,5% dos *smartwatches* mediram AF, CS e sono simultaneamente. Os sensores mais comuns nos *smartwatches* foram fotopletismografia, geolocalização e giroscópio. Todos os modelos foram encontrados com conectividade Bluetooth, 55% dos modelos apresentaram conectividade Wi-Fi e apenas 11,3% dos *smartwatches* tinham uma rede móvel. **Conclusão:** Esta revisão de escopo pode guiar estudos, intervenções e profissionais de saúde, além de ajudar os usuários finais a selecionarem um *smartwatch* apropriado para medir AF, CS e sono.

Registro da revisão de escopo: https://osf.io/3s9x5

Palavras-chave: *Monitores de atividade física; Dispositivos eletrônicos vestíveis; Atividade física; Comportamento sedentário; Sono.*

Introduction

The use of accelerometer data to measure movement behaviors (i.e., physical activity - PA, sedentary behavior - SB, and sleep) has significantly impacted the public health field over the last decade[1,2]. The increase in using objective measures instead of subjective measures (i.e., self-report questionnaires) leads to more precise information at the population level. Nowadays, there is a better understanding of the nature of these behaviors, their correlates, and determinants throughout the life course. Additionally, there is a growing body of strong and more reliable evidence regarding the isolated and combined dose-effect relationships between movement behaviors and several outcomes[1,3,4].

On the other hand, limitations such as restricted storage capacity, complex criteria for data collection/processing decisions[5], costs, and reduced user acceptability[6] have constrained their widespread use among researchers and practitioners. As technology continues to advance, smartwatches have emerged as potential solutions to mitigate these issues. These wrist-worn devices function as general-purpose computers equipped with sensors that allow the objective measurement of movement behavior parameters[7-9]. Another advantage that can provide valuable information in public health is that certain models offer wireless data extraction and transfer capabilities, facilitating real-time data access[7]. There are smartwatch models, such as those from Fitbit, which are commonly used in research on PA and cost less than USD 100.00, which is significantly cheaper than traditional accelerometers[10].

Moreover, some manufacturers provide software development kits and application programming interfaces to address practical challenges[7,8]. For instance, algorithms can be developed to prompt individuals to stand up or engage in PA after prolonged periods of sitting[11].

The global smartwatch market continues to expand, with sales exceeding 148 million units in 2022 and a forecast of 205 million units by 2027[12]. Additionally, estimates suggest that global shipments of smartwatches reached 156.5 million units in 2024, with projections for growth to 175 million units by 2028[13]. These data reinforce the growing acceptance of smartwatches, driven by high consumer demand for integrated features such as activity tracking, time display, navigation, and communication[14], which potentially enhances their acceptance and usefulness in daily life[7-9]. Despite these advancements and considering the potential impacts on population health surveillance, there remains a gap in the literature regarding general information about smartwatch models, sensors, metrics, and data transfer methods globally, capable of objectively measuring movement behaviors.

Hence, this scoping review aims to comprehensively map the technical characteristics of different smartwatch models. Valuable information can help improve decision-making in studies, interventions, and healthcare practices utilizing smartwatches as measurement instruments.

Methods

Protocol and registration

The protocol for this scoping review is registered on the Open Science Framework (https://osf.io/3s9x5), and followed the Joanna Briggs Institute guidelines for Scoping Reviews [15] and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews - PRISMA-ScR[16] as outlined in Supplementary material 1.

Eligibility criteria, sources of information and search strategy

The scoping review aimed to answer the following question: What are the technical characteristics of the primary smartwatch models capable of measuring movement behaviors? Only manufacturers with ≥ 3% of the global market share between 2017 and 2022 were included, as lower percentages were grouped as "other models," and the specialized sites that conduct peer reviews only provide results from 2017 onward. The criteria were identified using global shipment surveys conducted by a global technology market research firm in the Media and Telecommunications industry - Counterpoint®[17] and a leading company in online statistics and market of global data and business intelligence - Statista®[18]. Both sources provide information based on the most up-to-date analytical measures and the latest available data, which undergo peer review.

After identifying the leading smartwatch manufacturers, we accessed their respective official websites to identify the smartwatch models. The following criteria were used for model inclusion: (a) Models described as smartwatches by their manufacturers; (b) Wristwatch devices classified as general-purpose computers capable of network connection and equipped with sensors to monitor movement behaviors[9]; and (c) Models featuring at least an accelerometer sensor[19]. Models released in the same period as their previous versions were excluded if their sensors, metrics, and data transfer methods were identical to those of the previous version. These criteria ensured the exclusion of versions without any relevant technological modifications.

Upon identification, general information, technical specifications, and user manuals were preferably ac-

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cessed from their official websites, using the specific name of each model as the search term. When this information was unavailable on official websites, a search was conducted on the VERSUS website (www.versus.com) by combining the words "smartwatch" and the specific model. All searches were conducted between January 3rd and July 19th, 2022.

Selection of evidence sources and data extraction process and items

Two authors with experience in objective measure of movement behaviors and technology screening the official manuals and extracted the general and technical information into a excel spreadsheet. The descriptive information of the smartwatches was: manufacturer name, model, year of manufacturer, price, type and number of sensors, metrics, type of storage and data transfers, measures of behavioral, environmental, and physiological variables. To minimize discrepancies, a pilot screening was conducted based on eligibility criteria, randomly selecting ten smartwatch models. A third reviewer was consulted when necessary to reach a consensus.

Summarizing and reporting the results

The results were summarized and grouped according to each smartwatch model using tables and figures. The selected characteristics used to compile the results are among the most employed in studies utilizing wearable technology within the domains of health, wellness, and research pertaining to movement behavior parameters[7,8,10,20].

Results

Between 2017 and 2022, twelve manufacturers achieved at least a 3% market share in the global smartwatch market. By March 2022, eight of them remained. Apple® emerged as the largest smartwatch provider in the world in 2022, accounting for approximately 36% of shipments in the first quarter of the year. It was followed by Samsung® (10%), Huawei® (7%), Xiaomi® (5%), Garmin® (4%), Amazfit® (4%), Imoo® (3%), and Fitbit® (3%)[21].

A total of 321 smartwatch models were identified, and after applying the eligibility criteria (i.e., having at least an accelerometer sensor), 143 eligible models from 12 different manufacturers were included in this review, with prices ranging from USD 112.00 to USD 1,771.20, respectively (Figure 1). The number of smartwatch models, along with the minimum and maximum battery life, prices, and duration based on typical use, are categorized by each manufacturer in Table 1.

All smartwatch models have the capability to transfer data through Bluetooth connection, 55% through Wi-Fi, and approximately 11% through 3G or 4G mobile networks and can function autonomously for making phone calls and accessing the internet directly. With regard to connectivity, 10.5% of models can transfer data to the manufacturer's cloud in real-time, 11.9% to the cloud manually or on a scheduled basis, and 99.3% to the application installed on the smartphone. Manufacturers that allow data to be transferred to any person and authorize the creation of applications for various purposes include Apple®, Samsung®, Fitbit®, Amazfit®, Garmin®, Imoo®, and Huawei®. The possible methods of data transfer from smartwatches are presented according to each manufacturer in Table 1. The development support information by smartwatch models is not available in the official websites.

As more than 80.0% of smartwatch models did not have technical information provided by their manufacturers, simply indicating whether the sensor was present or not, the results were summarized by including the frequency of sensors for each manufacturer. Only the manufacturers Amazfit®, Huawei®, Fitbit®, and Oppo® provided the necessary information regarding accelerometer sensors, with 5 models incorporating a 6-axis accelerometer (Amazfit® and Huawei®) and 20 models utilizing a triaxial accelerometer (Amazfit®, Fitbit®, and Oppo®). A total of 118 smartwatch models lacked manufacturer-provided information regarding the number of axes in their accelerometers. The three most common sensors were photoplethysmography (82.5%), followed by geolocation (73.4%) and gyroscope (67.1%). The description and quantity of sensors for each smartwatch manufacturer are presented in Table 2.

All smartwatches' models included PA and step count, but only 32.2% a metric for SB, while 93.7% measured sleep duration. Only 32.2% of the smartwatches could measure PA, SB, and sleep simultaneously (Table 3). No manufacturer provides information on validity tests for measurements of PA, SB, or sleep.

For PA, the metrics were step counts, distance, and calories. For sleep, they included sleep duration, light sleep duration, deep sleep duration, sleep duration REM, sleep stages, and sleep quality. None of the manufacturers specify whether PA, SB, and sleep metrics are derived solely from an accelerometer or a combination of sensors. Specifications for each smartwatch model are detailed in supplementary material 2 and 3.

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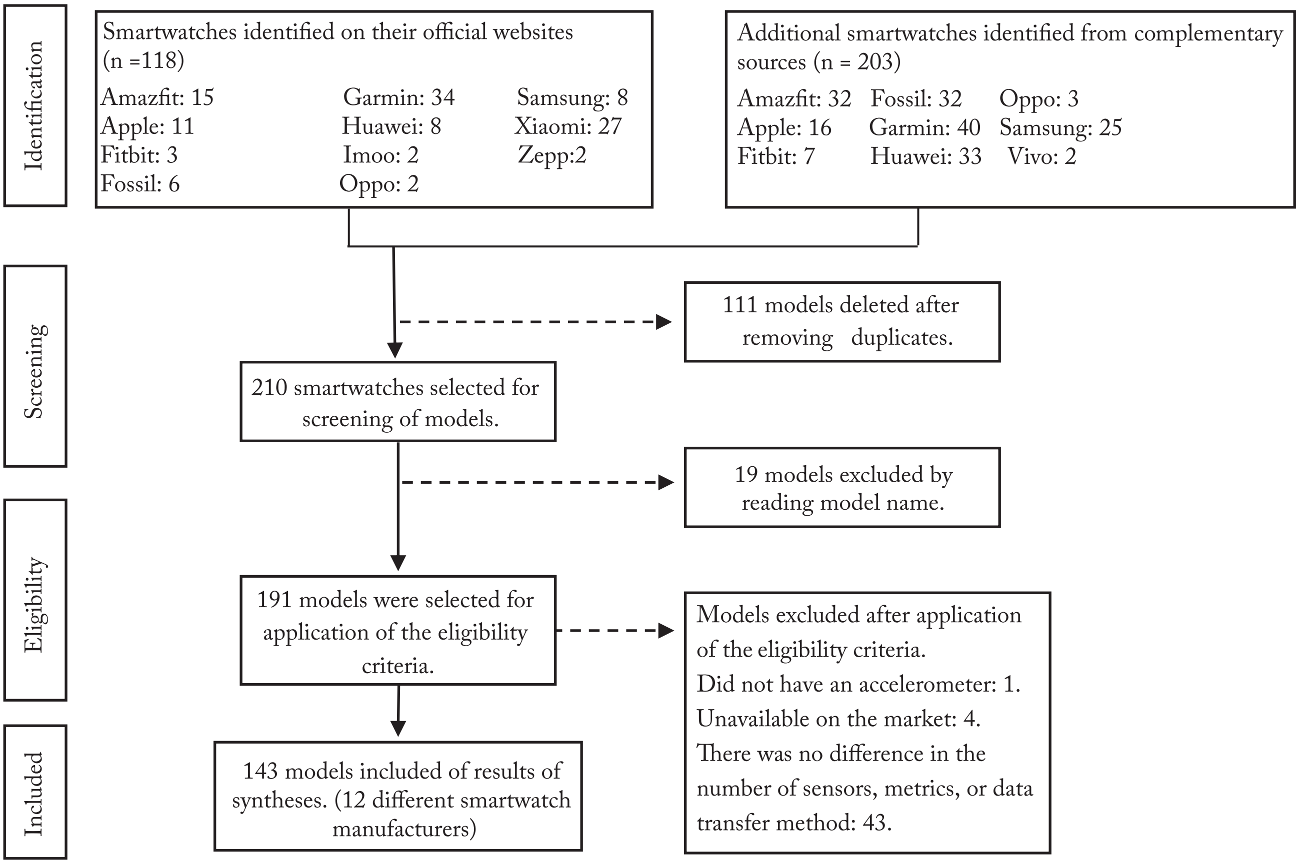

Figure 1 – Flowchart of the selection process of studies (PRISMA-ScR).

Table 1 – General characteristics and data transfer methods from smartwatch manufacturers

Manufacturer	Number of models	Minimum battery life	Maximum battery life	Battery life in days for typical use	Minimum and maximum prices	Bluetooth	Wi-fi	Mobile network 3G	Mobile network 4G	Cloud in real time	Cloud manual/ Scheduled	Smartphone application
	(n)	(hours)	(days)	(min - max)	(USD)*	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Amazfit®	27	7	120	5-45	47-60	27 (100.0)	10 (37)	1 (3.7)	1 (3.7)	1 (3.7)	1 (3.7)	26 (96.3)
Apple®	12	13	-	0.75-14	190 - 1083	12 (100.0)	12 (100.0)	6 (50.0)	6 (50.0)	6 (50.0)	7 (58.3)	12 (100.0)
Fitbit®	6	12	-	4-6	94 - 287	6 (100.0)	4 (66.7)	0 (0.0)	0 (0.0)	1 (16.7)	2 (33.3)	6 (100.0)
Fossil®	29	-	365	1-21	103 - 746	29 (100.0)	10 (34.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	29 (100.0)
Garmin®	39	4	365	5-50	86 - 1771	39 (100.0)	23 (59.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	39 (100.0)
Huawei®	9	3	21	5-14	102 - 667	9 (100.0)	2 (22.2)	2 (22.2)	2 (22.2)	2 (22.2)	2 (22.2)	9 (100.0)
Imoo®	2	-	21	-	129 - 272	2 (100.0)	2 (100.0)	2 (100.0)	2 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)
Oppo®	3	24	14	-	-	3 (100.0)	2 (66.7)	1 (33.3)	1 (33.3)	1 (33.3)	1 (33.3)	3 (100.0)
Samsung®	9	-	-	2-3	21 - 342	9 (100.0)	9 (100.0)	4 (44.4)	4 (44.4)	4 (44.4)	4 (44.4)	9 (100.0)
Vivo®	2	-	-	-	-	2 (100.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)
Xiaomi®	3	10	15	9-16	80 - 208	3 (100.0)	2 (66.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (100.0)
Zepp®	2	-	-	-	157 - 315	2 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (100.0)
All	143	-	-	-	21 - 1771	143 (100.0)	77 (55.0)	16 (11.3)	16 (11.3)	(10.5)	(11.9)	(99.3)

Note: - = unavailable; *Original price range in Brazilian Real (BRL), with approximate values in US Dollar (USD), based on the July 2022 exchange rate of approximately 5.4 BRL per USD.

Discussion

This scoping review aimed to map the technical characteristics of smartwatch models with at least the accelerometer sensor. We identified a total of 143 distinct

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Table 2 – Frequency of sensors by manufacturers.

Sensors	Amazfit® n = 27	Apple® n = 12	Fitbit® n = 6	Fossil® n = 29	Garmin® n = 39	Huawei® n = 9	Imoo® n = 2	Oppo® n = 3	Samsung® n = 9	Vivo® n = 2	Xiaomi® n = 3	Zepp® n = 2	All n = 143
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Photoplethysmography	100.0	100.0	100.0	34.5	89.7	100.0	0.0	100.0	100.0	100.0	100.0	100.0	82.5
Electrocardiogram	0.0	66.7	16.7	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0	8.4
Gyroscope	70.4	100.0	16.7	37.9	69.2	100.0	0.0	66.7	100.0	100.0	100.0	50.0	67.1
Geolocation	85.2	100.0	33.3	17.2	92.3	88.9	100.0	66.7	100.0	100.0	100.0	50.0	73.4
Ambient light	70.4	100.0	100.0	0.0	17.9	33.3	0.0	100.0	55.6	100.0	100.0	100.0	43.4
Atmospheric pressure	70.4	100.0	66.7	6.9	74.4	77.8	0.0	66.7	100.0	100.0	100.0	50.0	62.9
Compass	77.8	75.0	0.0	10.3	79.5	77.8	0.0	66.7	77.8	100.0	100.0	50.0	60.1
Oximeter	44.4	33.3	50.0	6.9	79.5	100.0	0.0	66.7	66.7	100.0	66.7	100.0	52.4
Bioimpedance	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.4	0.0	0.0	0.0	14.7
Depth	0.0	83.3	33.3	0.0	2.6	11.1	0.0	66.7	55.6	0.0	0.0	0.0	15.2
Temperature	11.1	0.0	33.3	0.0	76.9	55.6	0.0	0.0	0.0	0.0	0.0	0.0	28.0

Table 3 – Frequency of metrics by manufacturers.

Variables	Amazfit® n = 27	Apple® n = 12	Fitbit® n = 6	Fossil® n = 29	Garmin® n = 39	Huawei® n = 9	Imoo® n = 2	Oppo® n = 3	Samsung® n = 9	Vivo® n = 2	Xiaomi® n = 3	Zepp® n = 2	All n = 143
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Physical activity													
Physical activity	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Step counts	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Distance	100.0	100.0	100.0	100.0	100.0	88.9	100.0	66.7	100.0	100.0	100.0	50.0	96.5
Calories	100.0	100.0	100.0	100.0	94.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	98.6
Sedentary behavior													
Sedentary behavior*	92.6	83.3	83.3	3.4	0.0	0.0	0.0	0.0	0.0	100.0	0.0	50.0	32.2
Sleep parameters													
Sleep duration	100.0	100.0	100.0	93.1	82.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	93.7
Light sleep duration	63.0	16.7	83.3	0.0	53.8	22.2	0.0	0.0	33.3	0.0	33.3	0.0	35.7
Deep sleep duration	33.3	0.0	83.3	0.0	53.8	22.2	0.0	0.0	33.3	0.0	33.3	0.0	28.7
Sleep duration REM	29.6	0.0	83.3	0.0	48.7	22.2	0.0	0.0	33.3	0.0	33.3	0.0	26.6
Sleep stages	37.0	0.0	83.3	0.0	61.5	22.2	0.0	0.0	33.3	0.0	33.3	0.0	31.5
Sleep quality	63.0	50.0	16.7	72.4	61.5	44.4	100.0	100.0	100.0	0.0	100.0	0.0	62.9
Movement behavior													
PA+SB+SD	92.6	100.0	83.3	3.4	0.0	0.0	0.0	0.0	0.0	100.0	0.0	50	32.2
Other metrics													
Heart rate	100.0	100.0	100.0	34.5	92.3	100.0	0.0	100.0	100.0	100.0	100.0	100.0	83.2
Brightness	70.4	100.0	100.0	0.0	17.9	22.2	0.0	100.0	88.9	100.0	100.0	100.0	44.8
Altitude	59.3	100.0	66.7	6.9	74.4	77.8	0.0	66.7	100.0	0.0	100.0	50.0	59.4
Body temperature	14.8	0.0	50	0.0	76.9	44.4	0.0	0.0	0.0	0.0	0.0	0.0	28.7

*Note: * the definition of some behaviors may vary amongst manufacturers.* PA = Physical activity; SB = Sedentary behavior; SD = Sleep duration.

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smartwatch models from 12 manufacturers, capable of measuring PA, SB and/or sleep. Our findings reveal that manufacturers do not consistently provide clear information about which sensors are used to measure movement behaviors. For instance, while all devices have the accelerometer sensor, considered the gold standard for objectively measuring PA intensities[5,22], none of the manufacturers specify whether PA data is derived solely from an accelerometer or a combination of sensors. This limitation extends to measurements of SB and sleep.

Regarding accelerometers, five smartwatch models featured a 6-axis accelerometer, while 20 used a triaxial accelerometer. Notably, 118 manufacturers did not disclose the number of axes in their accelerometers. This lack of information restricts users' decision-making and hinders direct comparisons with other devices. Accelerometers assess body movement across various axes, with a higher axis count enhancing movement assessment precision. Consequently, providing detailed accelerometer information is essential for users and researchers in selecting suitable smartwatches. Additionally, the photoplethysmography sensor, depending on the version, facilitates the measurement of environmental (e.g., brightness) and physiological variables (e.g., body temperature, blood oxygenation, heart rate)[23].

The geolocation sensor, integral components of Global Positioning System (GPS), utilize 24 or more satellites orbiting the Earth and, calculate the position of an object by measuring the time difference between the emission and reception of radio signals transmitted by the satellites, ensuring continuous global coverage. Once a GPS device determines its distance from at least four satellites, it uses geometry to ascertain its location on Earth in three dimensions (latitude, longitude, and altitude)[24]. In this way, this can indicates distance traveled, speed, and precise activity locations, aiding contextual understanding of PA and SB[25].

The combined accelerometer and GPS data were able to correctly classify activity modes in 91% of observations. Furthermore, in both supervised and unsupervised environments, they successfully classified activities in 89%, encompassing a variety of movements (lying down, sitting, standing, walking, running, cycling on stationary bikes, rowing, playing soccer, Nordic walking, and cycling on regular bikes). Additionally, the GPS effectively identified the contexts and primary locations where PA and SB occur, providing a better understanding of people's interactions with the environment, whether at work, at home, during transportation, or during leisure activities [26]. Meanwhile, the gyroscope enhances device precision by capturing data on orientation, angular velocity, and aiding in activity type estimation[27,28].

Seven out of the 12 manufacturers investigated herein offer models capable of measuring parameters for PA, SB, and sleep across a 24-hour period, suitable for research purposes. However, there are limitations to overcome. For instance, PA metrics varied among manufacturers, with "step counts" being the sole measure provided uniformly. Conversely, advanced metrics for specific exercises/sports, such as heart rate, training zones, and exercise intensity for running, swimming, and strength training, were displayed by some manufacturers (e.g., Apple®). Yet, it remains unclear whether these metrics stem from objective accelerometer measurements[29].

In terms of SB metrics, manufacturers generally define SB as specific time intervals without movement, varying based on manufacturer settings. Notifications to prompt movement are sent when prolonged sedentary exposure is identified[30,31]. However, details regarding the type and duration of SB remain undisclosed.

Although manufacturers provide more detailed reports on the quantity of sleep metrics, such as duration, stages, and quality, compared to metrics for PA and SB, there is a lack of clarity on how each measure is taken. This could be relevant as smartwatches with multiple sensors and algorithms have the potential to identify specific activities and contexts (e.g., walking or running on a treadmill or outdoors)[32], as well as allowing the identification of specific SB and their contexts. The identification of the type and context of SB is relevant in research that distinguishes between screen time (such as watching TV or using mobile devices) and non-screen sedentary time (such as sitting at school or work, playing board games, or sitting in a car). This capability can significantly contribute to advancing knowledge about how different patterns and contexts of SB and PA influence health.

Utilizing such technology in research could align with behavior recommendations, aiding in their understanding. Moreover, a growing body of evidence demonstrates that interventions targeting increased PA time and reduced sedentary time show greater benefits when individuals use wearable devices for self-monitoring compared to those who do not[33]. Nevertheless, for comprehensive movement behavior assessment within a 24-hour period, detailed measurement specifics for each behavior are crucial.

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Regarding data transfer capabilities, smartwatch models lack detailed specifications about the component model/version responsible for data transfer, such as Bluetooth, Wi-Fi, or mobile network versions. This absence of specifics might lead to compatibility issues with receiving devices, potentially reducing data transfer speed or causing connection refusal, rendering data transfer impossible.

An aspect that demands attention is the lack of information regarding the psychometric properties of smartwatch models, such as validity, reliability, consistency, and accuracy of their measurements. Official and third-party websites do not provide this critical information, which is common in scientific literature. Highlighting the criteria of validity, accuracy, and reliability on official websites would enhance manufacturers' transparency and assist consumers in selecting suitable models. Furthermore, official websites only provide general and concise information about the latest commercially available models, making it challenging for users to choose models that meet their desired sensors and functions.

The cost of smartwatches is another relevant factor that can influence both everyday use and their application in scientific research. In this review, smartwatch prices ranged from USD 20.70 to USD 1,771.20, with all brands offering models priced lower than traditional research-grade accelerometers. This cost factor, which is crucial for logistical considerations and device selection in studies using accelerometers as the gold standard[5], can similarly inform decisions when planning the use of smartwatches in epidemiological research. Additionally, the wide price range allows individuals from different socioeconomic backgrounds to access these technologies, promoting greater adherence to the monitoring of health behaviors such as PA, SB, and sleep.

To our knowledge, this review is the first to map information from various smartwatch models, revealing areas that necessitate improvement. Smartwatch manufacturers should furnish comprehensive information about model specifications, particularly regarding sensors. Most manufacturers merely mention sensor names (e.g., accelerometer, gyroscope, photoplethysmography) without specifying sensor versions, whether sensors measure or estimate variables collected, or the data collected and categorized as PA, SB, or sleep.

Regarding storage capacity, most suppliers should provide more information. It was observed that most smartwatch manufacturers did not specify storage size; instead, they inform users about the technology's storage capability. This lack of information might be problematic for users requiring data storage for significant volumes.

Similarly, manufacturers should prioritize providing detailed information about the data transfer types for different smartwatch models. Currently, most manufacturers only inform users about the smartwatch's connection types (Bluetooth, Wi-Fi, and mobile network) without specifying their versions (e.g., 3.0, 4.0, 3G, 4G), pertaining to the transmission speed, range, and connection quality. Additionally, manufacturers did not disclose the data transfer frequency or the duration for which data can be stored on the device.

In terms of measurements, more manufacturers should offer SB measurements and provide more details on how they measure and define SB. Despite its association with health parameters[34], SB was the least available and detailed metric among smartwatch manufacturers. Although the accelerometer within this technology has the capability to measure this behavior, most manufacturers do not explore this function, nor do they consider different PA intensities. Manufacturers should disclose information about the validity and reliability of their models' measurements of PA, SB, and sleep to enhance transparency and enable decision-making based on these criteria. This area represents an intriguing field for future behavior measurement studies.

This study presents a comprehensive mapping of 143 globally marketed smartwatch models, focusing on the objective measurements of PA, SB, and sleep. We have pioneeringly identified significant gaps in the technical information provided by manufacturers, particularly concerning sensors, the measurements performed, and the methods of data transfer. This approach allows for a clearer understanding of the applicability of these devices in researching movement behaviors, providing valuable insights for both researchers and consumers. However, we acknowledge certain limitations in this mapping, such as the lack of specificity in manufacturers' information, which often fails to detail crucial aspects like the number of axes in accelerometers, the generation of sensors, and the available metrics. To mitigate these limitations, we sought information from third-party sources specialized in technology, but some data may still remain vague. Additionally, models released in the same period that did not differ in terms of sensors, metrics, or data transfer methods compared to the initial version were not included; therefore, the reported number of smartwatches may not reflect the exact number of de-

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vices currently available. However, we included the main models capable of measuring PA, body composition, and sleep, representing the most widely available on the market, which are sufficient to guide future choices.

In conclusion, this review identified 143 models from 12 smartwatch manufacturers with the highest market share capable of objectively measuring PA, SB, and sleep, as well as environmental and physiological variables. These features can guide the choice of a smartwatch for both professionals and everyday users aiming to support healthy habits. However, the lack of transparency from manufacturers in providing specific information limits detailed comparisons among models and may hinder users' decision-making, potentially restricting the advancement of scientific knowledge in this area. It is essential for manufacturers to improve the clarity of their specifications to foster further research and enhance product effectiveness.

Conflict of interest

The authors declare no conflict of interest.

Author's contributions

Silva JF: Conceptualization; Methodology; Formal analysis; Visualization; Writing – original draft; Approval of the final version. Germano-Soares AH: Conceptualization; Methodology; Formal analysis; Visualization; Writing – original draft; Approval of the final version. Silva LCB: Conceptualization; Visualization; Writing – review & editing; Approval of the final version. Barbosa Filho VC: Conceptualization; Methodology; Writing – review & editing; Approval of the final version. Oliveira TV: Conceptualization; Writing – review & editing; Approval of the final version. Silva TCA: Conceptualization; Formal analysis; Writing – review & editing; Approval of the final version. Tassitano RM: Conceptualization; Methodology; Formal analysis; Supervision; Visualization; Writing – original draft; Writing – review & editing; Approval of the final version.

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Declaration regarding the use of artificial intelligence tools in the article writing process

The authors did not use artificial intelligence tools for preparation of the manuscript.

Availability of research data and other materials

The contents underlying the research text are contained in the manuscript.

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Editor in Chief
Raphael Ritti-Dias
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Supplementary Material

Supplementary Material 1 - PRISMA-P Checklist. PRISMA-ScR (Preferred Reporting Items for Systematic review and Meta-Analysis extension for Scoping Reviews (PRISMA-ScR) 2018 checklist

Section	Item	PRISMA-ScR checklist item	Reported on page #
Title			
Title	1	Identify the report as a scoping review.	1
Abstract			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	1
Introduction			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	2
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	2
Methods			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	2
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	2
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	2
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	2
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	3
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	3
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	3
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	None
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	3
Results			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	3
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	None
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	None
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	3
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	3
Discussion			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	6
Limitations	20	Discuss the limitations of the scoping review process.	7
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	8
Funding			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	None

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JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.
* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.
† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).
‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.
§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).
From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

Supplementary material 2 - Cost and sensors for each smartwatch model.

Models	Cost (USD)	PPG	ECG	GY	GLC	OS	AP	CP	OX	BIO	DEP	TEMP
Amazfit BIP	75.00	✓	✗	✗	✓	✗	✓	✓	✗	✗	✗	✗
Amazfit BIP LITE	57.40	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Amazfit BIP S	66.90	✓	✗	✗	✓	✗	✗	✓	✗	✗	✗	✗
Amazfit BIP S lite	47.80	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Amazfit BIP U	47.80	✓	✗	✓	✗	✗	✗	✗	✓	✗	✗	✗
Amazfit BIP U PRO	57.40	✓	✗	✓	✓	✗	✗	✓	✓	✗	✗	✗
Amazfit GTR	123.40	✓	✗	✗	✓	✓	✓	✓	✗	✗	✗	✗
Amazfit GTR	165.30	✓	•	✓	✓	✓	✓	✓	-	✗	•	•
Amazfit GTR 2	100.70	✓	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗
Amazfit GTR 2e	164.70	✓	✗	✓	✓	✓	✓	✓	✓	✗	✗	✓
Amazfit GTR 3	183.00	✓	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗
Amazfit GTR 3 PRO	109.80	✓	✗	✓	✓	✓	✓	✓	✓	✗	✗	✓
Amazfit GTS	163.70	✓	✗	✓	✓	✓	✓	✓	✗	✗	✗	✗
Amazfit GTS 2	90.90	✓	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗
Amazfit GTS 2 mini	109.10	✓	✗	✓	✓	✓	✗	✗	✓	✗	✗	✗
Amazfit GTS 2e	155.90	✓	✗	✓	✓	✓	✓	✓	✓	✗	✗	✓
Amazfit GTS 3	46.30	✓	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗
Amazfit NEO	75.00	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Amazfit NEXO	57.40	✓	✗	✓	✓	✓	✓	✓	✗	✗	✗	✗
Amazfit STRATOS	83.30	✓	✗	✓	✓	✓	✓	✓	✗	✗	✗	✗
Amazfit STRATOS 3	194.40	✓	✗	✓	✓	✗	✓	✓	✗	✗	✗	✗
Amazfit STRATOS PLUS	129.60	✓	✗	✓	✓	✓	✓	✓	✗	✗	✗	✗
Amazfit T-REX	121.10	✓	✗	✗	✓	✓	✓	✓	✗	✗	✗	✗
Amazfit T-REX PRO	143.60	✓	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗
Amazfit Verge	153.20	✓	✗	✓	✓	✓	✓	✓	✗	✗	✗	✗
Amazfit Verge Lite	68.90	✓	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗

1 ✓ = Yes; ✗ = No; • = Not available; USD = Unite States dollar; PPG = Photopletimosgrafia; ECG = Electrocardiogram; GY = Gyroscope; PS = Photossensor; AP = Atmospheric pressure; CP = Compass; OX = Oxímeter; BIO = Bioimpedance; DEP = Depth; TEMP = Temperature. Original price range in Brazilian Real (BRL), with approximate values in US Dollar (USD), based on the July 2022 exchange rate of approximately 5.4 BRL per USD.
2 ✓ = Yes; ✗ = No; • = Not available; USD = Unite States dollar; PPG = Photopletimosgrafia; ECG = Electrocardiogram; GY = Gyroscope; PS = Photossensor; AP = Atmospheric pressure; CP = Compass; OX = Oxímeter; BIO = Bioimpedance; DEP = Depth; TEMP = Temperature. Original price range in Brazilian Real (BRL), with approximate values in US Dollar (USD), based on the July 2022 exchange rate of approximately 5.4 BRL per USD.

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Models	Cost (USD)	PPG	ECG	GY	GLC	OS	AP	CP	OX	BIO	DEP	TEMP
Amazfit X	315.90	✓	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗
Apple Watch SE GPS	267.10	✓	✗	✓	✓	✓	✓	✓	✗	✗	✓	✗
Apple Watch SE GPS + Celular	315.00	✓	✗	✓	✓	✓	✓	✓	✗	✗	✓	✗
Apple Watch Série 3 GPS	190.50	✓	✗	✓	✓	✓	✓	✗	✗	✗	✗	✗
Apple Watch Série 3 GPS + Celular	29.40	✓	✗	✓	✓	✓	✓	✗	✗	✗	✗	✗
Apple Watch Série 4 GPS	545.20	✓	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗
Apple Watch Série 4 GPS + Celular	556.30	✓	✓	✓	✓	✓	✓	✗	✗	✗	✓	✗
Apple Watch Série 5 GPS	500.00	✓	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗
Apple Watch Série 5 GPS + Celular	592.40	✓	✓	✓	✓	✓	✓	✓	✗	✗	✓	✗
Apple Watch Série 6 GPS	883.10	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗
Apple Watch Série 6 GPS + Celular	1,083.10	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗
Apple Watch Série 7 GPS	382.00	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗
Apple Watch Série 7 GPS + Celular	477.70	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗
FITBIT Versa	162.80	✓	✗	✗	✗	✓	✗	✗	✓	✗	✗	✗
FITBIT BLAZE	93.90	✓	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗
FITBIT Sense	287.20	✓	✓	✓	✓	✓	✓	✗	✗	✗	✓	✓
FITBIT Versa 2	113.90	✓	✗	✗	✗	✓	✓	✗	✓	✗	✗	✗
FITBIT Versa 3	•	✓	✗	✗	✓	✓	✓	✗	✓	✗	✓	✓
FITBIT Versa LITE	192.60	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗
Fossil Barstow	103.10	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Cameron	143.80	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Carlie	295.70	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Commuter	745.60	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Dive HR	116.50	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Garett HR	348.00	✓	✗	✗	✓	✗	✗	✓	✗	✗	✗	✗
Fossil Gen 5e	493.50	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Gen 6	167.60	✓	✗	✓	✓	✗	✗	✓	✓	✗	✗	✗
Fossil Grant	129.40	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Jacqueline	192.60	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Machine	338.10	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Nate	175.90	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Neely	116.50	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Neutra	525.70	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Q Control Gen 3 Sport	116.50	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Q Explorist Gen 3	218.10	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Q Explorist Gen 4	265.00	✓	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗

3 ✓ = Yes; ✗ = No; • = Not available; USD = Unite States dollar; PPG = Photopletimosgrafia; ECG = Electrocardiogram; GY = Gyroscope; PS = Photossensor; AP = Atmospheric pressure; CP = Compass; OX = Oxímeter; BIO = Bioimpedance; DEP = Depth; TEMP = Temperature. Original price range in Brazilian Real (BRL), with approximate values in US Dollar (USD), based on the July 2022 exchange rate of approximately 5.4 BRL per USD.

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Models	Cost (USD)	PPG	ECG	GY	GLC	OS	AP	CP	OX	BIO	DEP	TEMP
Fossil Q Founder	159.60	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Q Goodwin	•	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Q Grant Chronograph	123.90	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Q Harper	•	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Q HR Charter	118.90	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Q HR Collider	452.40	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Q Julianna HR Gen 5	152.60	✓	✗	✓	✓	✗	✓	✗	✗	✗	✗	✗
Fossil Q Marshal	198.30	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Q The Carlyle HR Gen 5	166.30	✓	✗	✓	✓	✗	✓	✓	✗	✗	✗	✗
Fossil Q Venture Gen 3	247.80	✗	✗	✓	✗	✗	✗	✗	✓	✗	✗	✗
Fossil Q Virginia	•	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fossil Q Wander	•	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗
Garmin Approach S20 + Sensor CT10	258.50	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗
Garmin Approach S42	191.50	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗
Garmin Approach S62	478.70	✓	✗	✓	✓	✗	✗	✓	✓	✗	✗	✗
Garmin D2 Air	775.90	✓	✗	✓	✓	✓	✓	✓	✓	✗	✗	✗
Garmin D2 Delta S	717.10	✓	✗	✓	✓	✗	✓	✓	✗	✗	✗	✓
Garmin Descent Mk2S	957.40	✓	✗	✓	✓	✗	✓	✓	✓	✗	✓	✓
Garmin Enduro	765.90	✓	✗	✓	✓	✗	✓	✓	✓	✗	✗	✓
Garmin Epix Gen2	957.40	✓	✗	✓	✓	✓	✓	✓	✓	✗	✗	✓
Garmin Fênix 6	440.40	✓	✗	✓	✓	✗	✓	✓	✓	✗	✗	✓
Garmin Fênix 6 Pro	622.30	✓	✗	✓	✓	✗	✓	✓	✓	✗	✗	✓
Garmin Fênix 6 Pro Solar	765.90	✓	✗	✓	✓	✗	✓	✓	✓	✗	✗	✓
Garmin Fênix 6 S	683.30	✓	✗	✓	✓	✗	✓	✓	✓	✗	✗	✓
Garmin Fênix 6 S Pro	622.30	✓	✗	✓	✓	✗	✓	✓	✓	✗	✗	✓
Garmin Fênix 6 S Pro Solar	765.90	✓	✗	✓	✓	✗	✓	✓	✓	✗	✗	✓
Garmin Fênix 7	670.20	✓	✗	✓	✓	✗	✓	✓	✓	✗	✗	✓
Garmin Fênix 7 Solar	765.90	✓	✗	✓	✓	✗	✓	✓	✓	✗	✗	✓
Garmin Fênix 7S	765.90	✓	✗	✓	✓	✗	✓	✓	✓	✗	✗	✓
Garmin Fênix 7S Solar	670.20	✓	✗	✓	✓	✗	✓	✓	✓	✗	✗	✓
Garmin Fenix 7X	861.70	✓	✗	✗	✓	✗	✗	✓	✓	✗	✗	✓
Garmin Fênix 7X Solar	287.20	✓	✗	✓	✓	✗	✓	✓	✓	✗	✗	✓
Garmin Forerunner 245	191.50	✓	✗	✗	✓	✗	✓	✓	✓	✗	✗	✓
Garmin Forerunner 45	191.50	✓	✗	✗	✓	✗	✗	✗	✗	✗	✗	✓
Garmin Forerunner 55	478.70	✓	✗	✗	✓	✗	✗	✗	✗	✗	✗	✓

4 ✓ = Yes; ✗ = No; • = Not available; USD = Unite States dollar; PPG = Photopletimosgrafia; ECG = Electrocardiogram; GY = Gyroscope; PS = Photossensor; AP = Atmospheric pressure; CP = Compass; OX = Oxímeter; BIO = Bioimpedance; DEP = Depth; TEMP = Temperature. Original price range in Brazilian Real (BRL), with approximate values in US Dollar (USD), based on the July 2022 exchange rate of approximately 5.4 BRL per USD.

5 ✓ = Yes; ✗ = No; • = Not available; USD = Unite States dollar; PPG = Photopletimosgrafia; ECG = ; GY = Gyroscope; PS = Photossensor; AP = Atmospheric pressure; CP = Compass; OX = Oxímeter; BIO = Bioimpedance; DEP = Depth; TEMP = Temperature. Original price range in Brazilian Real (BRL), with approximate values in US Dollar (USD), based on the July 2022 exchange rate of approximately 5.4 BRL per USD.

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Models	Cost (USD)	PPG	ECG	GY	GLC	OS	AP	CP	OX	BIO	DEP	TEMP
Garmin Forerunner 745	574.30	✔	✖	✔	✔	✖	✔	✔	✔	✖	✖	✔
Garmin Forerunner 945	248.90	✔	✖	✔	✔	✖	✔	✔	✔	✖	✖	✔
Garmin Instinct	383.00	✔	✖	✖	✔	✖	✔	✔	✖	✖	✖	✔
Garmin Instinct Solar	383.00	✔	✖	✖	✔	✖	✔	✔	✔	✖	✖	✔
Garmin Legacy Hero Series	239.30	✔	✖	✔	✔	✖	✔	✔	✔	✖	✖	✖
Garmin Lily	1,771.20	✔	✖	✖	✖	✔	✖	✖	✔	✖	✖	✖
Garmin MARQ Golfer	1,101.00	✔	✖	✔	✔	✖	✔	✔	✔	✖	✖	✔
Garmin quatix 6X Solar	239.30	✔	✖	✔	✔	✖	✔	✔	✔	✖	✖	✔
Garmin Swim 2	1,053.10	✔	✖	✖	✔	✖	✖	✖	✖	✖	✖	✖
Garmin tactix Delta - Edição Solar	335.10	✔	✖	✔	✔	✖	✔	✔	✔	✖	✖	✔
Garmin Venu	383.00	✔	✖	✔	✔	✔	✔	✔	✔	✖	✖	✔
Garmin Venu 2	191.50	✔	✖	✔	✔	✔	✔	✔	✔	✖	✖	✔
Garmin Venu SQ	315.90	✔	✖	✖	✔	✔	✖	✔	✔	✖	✖	✔
Garmin Vívoactive 4	86.20	✔	✖	✔	✔	✖	✔	✔	✔	✖	✖	✔
Garmin Vívofit Jr. 3	191.50	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖
Garmin Vívomove 3	765.90	✖	✖	✖	✖	✔	✔	✖	✔	✖	✖	✖
Huawei Watch 3	333.30	✔	✖	✔	✔	✔	✔	✔	✔	✖	✔	✔
Huawei Watch 3 Pro	666.60	✔	✖	✔	✔	✔	✔	✔	✔	✖	✖	✔
Huawei Watch D [6]	347.20	✔	✖	✔	✔	✔	✔	✔	✔	✖	✖	✔
Huawei Watch fit 2	•	✔	✖	✔	✔	✖	✔	✔	✔	✖	✖	✔
Huawei Watch Fit Mini	101.90	✔	✖	✔	✖	✖	✖	✖	✔	✖	✖	✖
Huawei Watch Fit New	101.90	✔	✖	✔	✔	✖	✖	✖	✔	✖	✖	✖
Huawei Watch GT Runner	388.70	✔	✖	✔	✔	✖	✔	✔	✔	✖	✖	✖
Huawei Watch GT2 Pro	277.80	✔	✖	✔	✔	✖	✔	✔	✔	✖	✖	✖
Huawei Watch GT3	296.30	✔	✖	✔	✔	✖	✔	✔	✔	✖	✖	✔
Imoo Z1	•	✖	✖	✖	✔	✖	✖	✖	✖	✖	✖	✖
Imoo Z6	•	✖	✖	✖	✔	✖	✖	✖	✖	✖	✖	✖
Oppo Watch Free	•	✔	✖	✖	✖	✔	✖	✖	✔	✖	✖	✖
Oppo Watch LTE	•	✔	✖	✔	✔	✔	✔	✔	✔	✖	✔	✖
Oppo Watch mm Wi-fi	•	✔	✖	✔	✔	✔	✔	✔	✖	✖	✔	✖
Samsung Galaxy Watch	•	✔	✖	✔	✔	✖	✔	✔	✖	✖	✖	✖
Samsung Galaxy Watch 3	222.20	✔	✖	✔	✔	✖	✔	✔	✔	✖	✖	✖
Samsung Galaxy Watch 3 LTE	222.20	✔	✖	✔	✔	✔	✔	✖	✔	✖	✔	✖
Samsung Galaxy Watch 4	20.70	✔	✖	✔	✔	✔	✔	✔	✔	✔	✔	✖
Samsung Galaxy Watch 4 LTE	233.30	✔	✔	✔	✔	✔	✔	✖	✔	✔	✔	✖
Samsung Galaxy Watch 4 Classic	342.20	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✖

6 ✔ = Yes; ✖ = No; • = Not available; USD = Unite States dollar; PPG = Photopletimosgrafia; ECG = Electrocardiogram; GY = Gyroscope; PS = Photossensor; AP = Atmospheric pressure; CP = Compass; OX = Oxímeter; BIO = Bioimpedance; DEP = Depth; TEMP = Temperature. Original price range in Brazilian Real (BRL), with approximate values in US Dollar (USD), based on the July 2022 exchange rate of approximately 5.4 BRL per USD.

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Models	Cost (USD)	PPG	ECG	GY	GLC	OS	AP	CP	OX	BIO	DEP	TEMP
Samsung Galaxy Watch 4 Classic LTE	333.30	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×
Samsung Galaxy Watch Active	166.50	✓	×	✓	✓	×	✓	✓	×	×	×	×
Samsung Galaxy Watch Active 2 LTE	259.10	✓	×	✓	✓	×	✓	✓	×	×	×	×
Vivo Watch 2	•	✓	•	✓	✓	✓	✓	✓	✓	×	•	•
Vivo Watch	•	✓	•	✓	✓	✓	✓	✓	✓	×	•	•
Xiaomi Mi Watch S1 Active	175.90	✓	×	✓	✓	✓	✓	✓	✓	×	×	×
Xiaomi Mi Watch Global	80.00	✓	×	✓	✓	✓	✓	✓	✓	×	×	×
Xiaomi Mi Watch Lite	208.30	✓	×	✓	✓	✓	✓	✓	×	×	×	×
Zepp E	157.40	✓	•	×	×	✓	×	×	✓	×	•	•
Zepp Z	314.80	✓	•	✓	✓	✓	✓	✓	✓	×	•	•

Supplementary material 3 – Measurement for each smartwatch models.

Models	PA	SB	SD	LSD	DSD	SDREM	SS	SQ	HR	L	D	A	C	ST	BT
Amazfit BIP [8]	✓	✓	✓	•	•	•	•	✓	✓	×	✓	✓	✓	✓	×
Amazfit BIP LITE	✓	✓	✓	✓	✓	•	•	✓	✓	×	✓	×	✓	✓	×
Amazfit BIP S	✓	✓	✓	•	•	•	•	✓	✓	×	✓	×	✓	✓	×
Amazfit BIP S lite	✓	✓	✓	✓	✓	×	•	×	✓	×	✓	×	✓	✓	×
Amazfit BIP U	✓	×	✓	✓	✓	✓	•	✓	✓	×	✓	×	✓	✓	×
Amazfit BIP U PRO	✓	✓	✓	✓	✓	✓	•	✓	✓	×	✓	×	✓	✓	×
Amazfit GTR	✓	✓	✓	•	•	×	•	•	✓	✓	✓	✓	✓	✓	×
Amazfit GTR	✓	✓	✓	•	•	•	•	×	✓	✓	✓	✓	✓	✓	×
Amazfit GTR 2	✓	✓	✓	•	•	•	✓	✓	✓	✓	✓	✓	✓	✓	✓
Amazfit GTR 2e	✓	✓	✓	•	•	•	✓	✓	✓	✓	✓	✓	✓	✓	×
Amazfit GTR 3	✓	✓	✓	•	•	•	✓	✓	✓	✓	✓	✓	✓	✓	✓
Amazfit GTR 3 PRO	✓	✓	✓	•	•	•	✓	✓	✓	✓	✓	✓	✓	✓	×
Amazfit GTS	✓	✓	✓	•	•	•	×	✓	✓	✓	✓	✓	✓	✓	×
Amazfit GTS 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×
Amazfit GTS 2 mini	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	✓	✓	×
Amazfit GTS 2e	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Amazfit GTS 3	✓	✓	✓	✓	•	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Amazfit NEO	✓	✓	✓	✓	•	✓	×	×	✓	×	✓	×	✓	✓	×
Amazfit NEXO	✓	×	✓	✓	•	×	×	×	✓	✓	✓	×	✓	✓	×
Amazfit STRATOS	✓	✓	✓	✓	✓	×	×	×	✓	✓	✓	✓	✓	✓	×
Amazfit STRATOS 3	✓	✓	✓	✓	•	×	×	×	✓	×	✓	✓	✓	✓	×

7 ✓ = Yes; × = No; • = Not available; USD = Unite States dollar; PPG = Photopletimosgrafia; ECG = Electrocardiogram; GY = Gyroscope; PS = Photossensor; AP = Atmospheric pressure; CP = Compass; OX = Oxímeter; BIO = Bioimpedance; DEP = Depth; TEMP = Temperature. Original price range in Brazilian Real (BRL), with approximate values in US Dollar (USD), based on the July 2022 exchange rate of approximately 5.4 BRL per USD.

8 ✓ = Yes; × = No; • = Not available; PA = Physical activity; SB = Sedentary behavior; SD = Sleep Duration; LSD = Ligth sleep duration; DSD = Deep sleep duration; SDREM = Sleep duration rapid eyes movement; SS = Sleep stage; SQ = Sleep Quality; HR = Heart rate; L = Luminosity; D = Distance; A = Altitude; C = Calories; St = Steps; BT= Body Temperature.

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Models	PA	SB	SD	LSD	DSD	SDREM	SS	SQ	HR	L	D	A	C	ST	BT
Amazfit STRATOS PLUS	✓	✓	✓	✓	•	•	•	✗	✓	✓	✓	✓	✓	✓	✗
Amazfit T-REX	✓	✓	✓	✓	✗	✗	✗	✗	✓	✓	✓	✗	✓	✓	✗
Amazfit T-REX PRO	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗
Amazfit Verge	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✗
Amazfit Verge Lite	✓	✓	✓	✓	✗	✗	✗	✗	✓	✓	✓	✗	✓	✓	✗
Amazfit X	✓	✓	✓	✗	✗	✗	✓	✓	✓	✓	✓	✗	✓	✓	✗
Apple Watch SE GPS	✓	✓	✓	✓	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✗
Apple Watch SE GPS + Celular	✓	✓	✓	✓	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✗
Apple Watch Série 3 GPS	✓	✓	✓	•	•	•	•	✓	✓	✓	✓	✓	✓	✓	✗
Apple Watch Série 3 GPS + Celular	✓	✓	✓	•	•	•	•	✓	✓	✓	✓	✓	✓	✓	✗
Apple Watch Série 4 GPS	✓	✓	✓	•	•	•	•	✓	✓	✓	✓	✓	✓	✓	✗
Apple Watch Série 4 GPS + Celular	✓	✓	✓	•	•	•	•	✓	✓	✓	✓	✓	✓	✓	✗
Apple Watch Série 5 GPS	✓	✓	✓	•	•	•	•	✓	✓	✓	✓	✓	✓	✓	✗
Apple Watch Série 5 GPS + Celular	✓	✓	✓	•	•	•	•	✓	✓	✓	✓	✓	✓	✓	✗
Apple Watch Série 6 GPS	✓	✓	✓	•	•	•	•	✗	✓	✓	✓	✓	✓	✓	✗
Apple Watch Série 6 GPS + Celular	✓	✓	✓	•	•	•	•	✗	✓	✓	✓	✓	✓	✓	✗
Apple Watch Série 7 GPS	✓	✓	✓	•	•	•	•	✗	✓	✓	✓	✓	✓	✓	✗
Apple Watch Série 7 GPS + Celular	✓	✓	✓	•	•	•	•	✗	✓	✓	✓	✓	✓	✓	✗
FITBIT Versa	✓	✓	✓	✗	✗	✗	✗	✗	✓	✓	✓	✗	✓	✓	✗
FITBIT BLAZE	✓	✗	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✗
FITBIT Sense	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓
FITBIT Versa 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
FITBIT Versa 3 [9]	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓
FITBIT Versa LITE	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓	✓	✗
Fossil Barstow	✓	✗	✓	✗	✗	✗	✗	✓	✗	✗	✓	✗	✓	✓	✗
Fossil Cameron	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓	✗
Fossil Carlie	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓	✗
Fossil Commuter	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓	✗
Fossil Dive HR	✓	✗	✓	✗	✗	✗	✗	✓	✓	✗	✓	✗	✓	✓	✗
Fossil Garett HR	✓	✗	✓	✗	✗	✗	✗	✗	✓	✗	✓	✗	✓	✓	✗
Fossil Gen 5e	✓	✗	✓	✗	✗	✗	✗	✓	✓	✗	✓	✗	✓	✓	✗
Fossil Gen 6	✓	✓	✓	✗	✗	✗	✗	✓	✓	✗	✓	✗	✓	✓	✗
Fossil Grant	✓	✗	✓	✗	✗	✗	✗	✓	✗	✗	✓	✗	✓	✓	✗
Fossil Jacqueline	✓	✗	✓	✗	✗	✗	✗	✓	✗	✗	✓	✗	✓	✓	✗
Fossil Machine	✓	✗	✓	✗	✗	✗	✗	✓	✗	✗	✓	✗	✓	✓	✗

9 ✓ = Yes; ✗ = No; • = Not available; PA = Physical activity; SB = Sedentary behavior; SD = Sleep Duration; LSD = Ligth sleep duration; DSD = Deep sleep duration; SDREM = Sleep duration rapid eyes movement; SS = Sleep stage; SQ = Sleep Quality; HR = Heart rate; L = Luminosity; D = Distance; A = Altitude; C = Calories; St = Steps; BT = Body Temperature.

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Models	PA	SB	SD	LSD	DSD	SDREM	SS	SQ	HR	L	D	A	C	ST	BT
Fossil Nate	✓	✗	✓	✗	✗	✗	✗	✓	✗	✗	✓	✗	✓	✓	✗
Fossil Neely	✓	✗	✓	✗	✗	✗	✗	✓	✗	✗	✓	✗	✓	✓	✗
Fossil Neutra	✓	✗	✓	✗	✗	✗	✗	✓	✗	✗	✓	✗	✓	✓	✗
Fossil Q Control Gen 3 Sport	✓	✗	✓	✗	✗	✗	✗	✓	✗	✗	✓	✗	✓	✓	✗
Fossil Q Explorist Gen 3	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓	✗
Fossil Q Explorist Gen 4	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✗	✓	✓	✗
Fossil Q Founder	✓	✗	✓	✗	✗	✗	✗	✓	✗	✗	✓	✗	✓	✓	✗
Fossil Q Goodwin	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓	✗
Fossil Q Grant Chronograph	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓	✗
Fossil Q Harper	✓	✗	✓	✗	✗	✗	✗	✓	✗	✗	✓	✗	✓	✓	✗
Fossil Q HR Charter	✓	✗	✓	✗	✗	✗	✗	✓	✓	✗	✓	✗	✓	✓	✗
Fossil Q HR Collider 10	✓	✗	✓	✗	✗	✗	✗	✓	✓	✗	✓	✗	✓	✓	✗
Fossil Q Julianna HR Gen 5	✓	✗	✓	✗	✗	✗	✗	✓	✓	✗	✓	✓	✓	✓	✗
Fossil Q Marshal	✓	✗	✓	✗	✗	✗	✗	✓	✓	✗	✓	✗	✓	✓	✗
Fossil Q The Carlyle HR Gen 5	✓	✗	✓	✗	✗	✗	✗	✓	✓	✗	✓	✓	✓	✓	✗
Fossil Q Venture Gen 3	✓	✗	✓	✗	✗	✗	✗	✓	✗	✗	✓	✗	✓	✓	✗
Fossil Q Virginia	✓	✗	✓	✗	✗	✗	✗	✓	✗	✗	✓	✗	✓	✓	✗
Fossil Q Wander	✓	✗	✓	✗	✗	✗	✗	✓	✗	✗	✓	✗	✓	✓	✗
Garmin Approach S20 + Sensor CT10	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓	✗
Garmin Approach S42	✓	✗	✓	✗	✗	✗	✗	✓	✗	✗	✓	✗	✗	✓	✗
Garmin Approach S62	✓	✗	✓	✗	✗	✗	✗	✗	✓	✗	✓	✗	✓	✓	✗
Garmin D2 Air	✓	✗	✓	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓
Garmin D2 Delta S	✓	✗	✓	✗	✗	✗	✗	✓	✓	✗	✓	✓	✓	✓	✓
Garmin Descent Mk2S	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓
Garmin Enduro	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓
Garmin Epix Gen2	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Garmin Fênix 6 11	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓
Garmin Fênix 6 Pro	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓
Garmin Fênix 6 Pro Solar	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓
Garmin Fênix 6 S	✓	✗	✓	✗	✗	✗	✗	✓	✓	✗	✓	✓	✓	✓	✓
Garmin Fênix 6 S Pro	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓
Garmin Fênix 6 S Pro Solar	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓
Garmin Fênix 7	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓
Garmin Fênix 7 Solar	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓

10 ✓ = Yes; ✗ = No; • = Not available; PA = Physical activity; SB = Sedentary behavior; SD = Sleep Duration; LSD = Ligth sleep duration; DSD = Deep sleep duration; SDREM = Sleep duration rapid eyes movement; SS = Sleep stage; SQ = Sleep Quality; HR = Heart rate; L= Luminosity; D = Distance; A = Altitude; C = Calories; St = Steps; BT= Body Temperature.

11 ✓ = Yes; ✗ = No; • = Not available; PA = Physical activity; SB = Sedentary behavior; SD = Sleep Duration; LSD = Ligth sleep duration; DSD = Deep sleep duration; SDREM = Sleep duration rapid eyes movement; SS = Sleep stage; SQ = Sleep Quality; HR = Heart rate; L = Luminosity; D = Distance; A = Altitude; C = Calories; St = Steps; BT = Body Temperature.

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Models	PA	SB	SD	LSD	DSD	SDREM	SS	SQ	HR	L	D	A	C	ST	BT
Garmin Fênix 7S	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓
Garmin Fênix 7S Solar 12	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓
Garmin Fenix 7X	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✓	✗	✓	✓	✓
Garmin Fênix 7X Solar	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓
Garmin Forerunner 245	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓	✓	✓	✓
Garmin Forerunner 45	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✗	✓	✓	✗
Garmin Forerunner 55	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✗	✓	✓	✗
Garmin Forerunner 745	✓	✗	✓	✗	✗	✗	✓	✓	✓	✗	✓	✓	✓	✓	✓
Garmin Forerunner 945	✓	✗	✓	✗	✗	✗	✓	✓	✓	✗	✓	✓	✓	✓	✓
Garmin Instinct	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓	✓	✓	✓
Garmin Instinct Solar	✓	✗	✓	✗	✗	✗	✗	✗	✓	✗	✓	✓	✓	✓	✓
Garmin Legacy Hero Series	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓
Garmin Lily	✓	✗	✓	✓	✓	✓	✓	✗	✓	✓	✓	✗	✓	✓	✗
Garmin MARQ Golfer	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓	✓	✓	✓
Garmin quatix 6X Solar	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓	✓	✓	✓
Garmin Swim 2	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✗	✓	✓	✗
Garmin tactix Delta - Edição Solar	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓
Garmin Venu	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Garmin Venu 2	✓	✗	✓	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓
Garmin Venu SQ	✓	✗	✓	✓	✓	✗	✓	✗	✓	✓	✓	✗	✓	✓	✓
Garmin Vívoactive 4	✓	✗	✓	✓	✓	✓	✓	✗	✓	✗	✓	✓	✓	✓	✓
Garmin Vívofit Jr. 3	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓	✗
Garmin Vívomove 3	✓	✗	✓	✓	✓	✗	✓	✗	✓	✓	✓	✓	✓	✓	✗
Huawei Watch 3	✓	✗	✓	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓
Huawei Watch 3 Pro	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
Huawei Watch D 13	✓	✗	✓	✗	✗	✗	✗	✗	✓	✗	✓	✓	✓	✓	✓
Huawei Watch fit 2	✓	✗	✓	✗	✗	✗	✗	✗	✓	✗	✓	✓	✓	✓	✓
Huawei Watch Fit Mini	✓	✗	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✓	✓	✗
Huawei Watch Fit New	✓	✗	✓	✗	✗	✗	✗	✓	✓	✗	✓	✗	✓	✓	✗
Huawei Watch GT Runner	✓	✗	✓	✗	✗	✗	✗	✗	✓	✗	✓	✓	✓	✓	✗
Huawei Watch GT2 Pro	✓	✗	✓	✗	✗	✗	✗	✗	✓	✗	✓	✓	✓	✓	✗
Huawei Watch GT3	✓	✗	✓	✗	✗	✗	✗	✗	✓	✗	✓	✓	✓	✓	✓
Imoo Z1	✓	✗	✓	✗	✗	✗	✗	✓	✗	✗	✓	✗	✓	✓	✗
Imoo Z6	✓	✗	✓	✗	✗	✗	✗	✓	✗	✗	✓	✗	✓	✓	✗

12 ✓ = Yes; ✗ = No; • = Not available; PA = Physical activity; SB = Sedentary behavior; SD = Sleep Duration; LSD = Ligth sleep duration; DSD = Deep sleep duration; SDREM = Sleep duration rapid eyes movement; SS = Sleep stage; SQ = Sleep Quality; HR = Heart rate; L = Luminosity; D = Distance; A = Altitude; C = Calories; St = Steps; BT = Body Temperature.

13 ✓ = Yes; ✗ = No; • = Not available; PA = Physical activity; SB = Sedentary behavior; SD = Sleep Duration; LSD = Ligth sleep duration; DSD = Deep sleep duration; SDREM = Sleep duration rapid eyes movement; SS = Sleep stage; SQ = Sleep Quality; HR = Heart rate; L = Luminosity; D = Distance; A = Altitude; C = Calories; St = Steps; BT = Body Temperature.

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Models	PA	SB	SD	LSD	DSD	SDREM	SS	SQ	HR	L	D	A	C	ST	BT
Oppo Watch Free	✓	✗	✓	✗	✗	✗	✗	✓	✓	✓	✗	✗	✓	✓	✗
Oppo Watch LTE	✓	✗	✓	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✗
Oppo Watch mm Wi-fi	✓	✗	✓	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✗
Samsung Galaxy Watch	✓	•	✓	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✗
Samsung Galaxy Watch 3	✓	•	✓	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✗
Samsung Galaxy Watch 3 LTE	✓	✗	✓	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✗
Samsung Galaxy Watch 4	✓	✗	✓	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✗
Samsung Galaxy Watch 4 LTE	✓	✗	✓	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✗
Samsung Galaxy Watch 4 Classic	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
Samsung Galaxy Watch 4 Classic LTE	✓	•	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
Samsung Galaxy Watch Active	✓	•	✓	✗	✗	✗	✗	✓	✓	✗	✓	✓	✓	✓	✗
Samsung Galaxy Watch Active 2 LTE	✓	•	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
Vivo Watch 2	✓	✓	✓	•	•	•	•	•	✓	✓	•	•	✓	✓	•
Vivo Watch	✓	✓	✓	•	•	•	•	•	✓	✓	•	•	✓	✓	•
Xiaomi Mi Watch S1 Active	✓	✗	✓	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✗
Xiaomi Mi Watch Global 14	✓	✗	✓	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✗
Xiaomi Mi Watch Lite	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
Zepp E	✓	•	✓	•	•	•	•	✗	✓	✓	✗	✗	✓	✓	✗
Zepp Z	✓	✓	✓	•	•	•	•	✗	✓	✓	✓	✓	✓	✓	✗

14 ✓ = Yes; ✗ = No; • = Not available; PA = Physical activity; SB = Sedentary behavior; SD = Sleep Duration; LSD = Ligth sleep duration; DSD = Deep sleep duration; SDREM = Sleep duration rapid eyes movement; SS = Sleep stage; SQ = Sleep Quality; HR = Heart rate; L = Luminosity; D = Distance; A = Altitude; C = Calories; St = Steps; BT = Body Temperature.

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Reviewers' assessment

The reviews of this article were originally conducted in Portuguese. This version has been translated using ChatGPT and subsequently reviewed by the Chief Editors.

Reviewer A

Anonymous

- Was any indication of plagiarism observed in the manuscript?
  No
- Did the authors provide clarification on the ethical procedures adopted for conducting the research?
  Not applicable

Results

- Paragraph 4, line 5: Wouldn't it be models? There are 12 manufacturers
- Paragraph 5, line 4: Review. The authors have only described the acronym in the Abstract.
- Otherwise, review it to adjust it throughout the text.

Conclusion

- Paragraph 1, line 2: Review. The authors have only described the acronym in the Abstract.
- Otherwise, review it to adjust it throughout the text.

References

- Review the formation of articles
- Model: Hallal PC, Victora CG, Wells JCK, Lima RC. Physical inactivity: prevalence and associated variables in Brazilian adults. Med Sci Sports Exerc. 2003;35(11):1894-900. doi: 10.1249/01.MSS.0000093615.33774.0E.

Comments to the author:

- We congratulate the authors for their work.
- The review text presents points that require specific adjustments.
- In addition, please review the formatting of the references, in accordance with the journal's standards.

Decision

- Minor revision

Reviewer B

Anonymous

Format

- Does the article comply with the rules for preparing manuscripts for submission to the Revista Brasileira de Atividade Física e Saúde?
  Partially
- Regarding formal aspects, is the manuscript well-structured, including sections such as introduction, methods, results, and discussion (with the conclusion as part of the discussion)?
  Partially
- Is the language appropriate, clear, precise, and objective?
  Yes
- Were any indications of plagiarism observed in the manuscript?
  No

  Suggestions/Comments:
- The abstract section does not include the article's title, as required by the submission guidelines.
- Reference 5 lacks the publisher's name.
- The conclusion appears as a separate topic rather than being integrated into the discussion.

Abstract

- Are the abstract and summary adequate (including objectives, information about study participants, studied variables, main results, and a conclusion) and do they reflect the manuscript's content?
  Yes

  Suggestions/Comments:
- The keywords in the Portuguese abstract appear to be direct translations of those in the English abstract, such as "dispositivos eletrônicos vestíveis." It is recommended to use terms from the Health Sciences Descriptors (DeCS) database to ensure consistency and relevance.

Introduction

- Was the research problem clearly stated and defined?
  Yes
- Is the research problem adequately contextualized within the existing knowledge, moving from the general to the specific?
  Yes
- Are the reasons justifying the study (including the

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authors' assumptions about the problem) well established in the writing?
Yes
- Are the references used to support the research problem current and pertinent to the topic?
Yes
- Was the objective clearly presented?
Yes
Suggestions/Comments:
- The authors provide a good foundation and clearly explain the study's problem. However, the issue of costs is only briefly mentioned as a justification for potentially replacing accelerometers with smartwatches. It is suggested that this topic be expanded in the introduction, as it seems to be an important aspect of the study.

Methods
- Are the methodological procedures generally appropriate for studying the research problem?
Yes
- Are the methodological procedures sufficiently detailed?
Yes
- Was the procedure for selecting or recruiting participants adequate for the problem studied and described clearly and objectively?
Partially
- Were the instruments used for data collection described, including their psychometric properties (e.g., reproducibility, internal consistency, and validity) and, when relevant, the operational definitions of variables?
Yes
- Is the data analysis plan adequate and sufficiently described?
Not applicable
- Were the inclusion and/or exclusion criteria for sample selection described and appropriate for the study?
Partially
- Did the authors clarify the ethical procedures adopted for conducting the research?
Not applicable
Suggestions/Comments:
- The authors used a criterion (≥3% between 2017 and 2022) to select smartwatch brands. However, considering the study's aim to provide academic insights, it might be beneficial to highlight brands/models already used in academic research for comparison and to aid future studies.
- Exclusion criteria for selecting smartwatch models were not detailed.

Results
- Are the use of tables and figures appropriate, facilitating the adequate presentation of the study's findings?
Yes
- Is the number of illustrations consistent with the journal's submission guidelines?
Yes
- Is the number of participants in each study stage, along with reasons for losses and refusals, presented in the manuscript?
Yes
- Are the participants' characteristics sufficiently described?
Yes
- Are the results presented adequately, emphasizing the main findings and avoiding unnecessary repetition?
Yes
Suggestions/Comments:
- In line with topics raised in the introduction and methods sections, consider including cost-related data for the models analyzed in the study. Highlight models already used in scientific research within the results (and corresponding tables).

Discussion
- Are the main findings of the study presented?
Yes
- Are the study's strengths and limitations presented and discussed?
Partially
- Are the results discussed in light of the study's limitations and existing knowledge on the topic?
Yes
- Are the potential contributions of the study's main findings to scientific development, innovation, or real-world applications discussed?
Yes
Suggestions/Comments:
- The arguments on page 10 (lines 24–25) and page 11 (lines 1–4) seem debatable. Whether someone is watching TV or reading a book, their movement pattern remains the same: sedentary. Revising this

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text to focus on movement patterns rather than specific activities might make the argument clearer.
- The section discussing the validity and reliability of smartwatch data (page 11, lines 16–23) is crucial. Consider elaborating on this point and correlating it with models already in academic use, as suggested earlier.

Conclusion

- Was the study's conclusion adequately presented and consistent with its objective?
  Yes
- Is the study's conclusion original?
  Yes

  Suggestions/Comments:
- The conclusion aligns with the study's aim. However, it could be expanded by incorporating information on costs and comparisons with academically used models.

References

- Are the references current and sufficient?
  Yes
- Are most references original articles?
  Yes
- Do the references comply with the journal's standards (quantity and format)?
  Yes
- Are citations in the text adequate, i.e., do they substantiate the claims made?
  Yes

  Suggestions/Comments:
- 63% of the references are original articles.
- Updating references to include more recent studies (2023–2024) would strengthen the manuscript.

Comments to the author

- The study aims to present smartwatch models by brand. Including key accelerometer models for comparison could add significant value, especially in terms of features like the number of axes used.
- Expanding the discussion on smartwatch accuracy, particularly for activity monitoring parameters, would enhance relevance in academic contexts where data reliability is crucial.
- Detailing smartwatch costs and comparing them to accelerometers would provide a more comprehensive analysis, which could significantly impact decision-making in daily and academic applications.

Decision

- Major revisions required.

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