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Physical Activity Measurement for Hearing Impairments in Different Age Level

Shokhan Omar Abdulrahman[1, 2], Mohd Radzani Abdul Razak[1], Mohd Hanafi Mohd Yasin[1], Ma Dauwed[3]

[1]*Faculty of Education, Universiti Kabangsaan Malaysia, 43600 Bangi, Selangor, Malaysia*
[2]*School of Physical Education, University of Sulaimani, Sulaimani, Iraq.*
[3]*Faculty of Information Science and Technology, Universiti Kabangsaan Malaysia, 43600 Bangi, Selangor, Malaysia.*
Corresponding Author: Shokhan Omar Abdulrahman

ABSTRACT: *Physical activity refers to habitual activities that can be determined by frequency, for example, the number of times per week. Low physical activity is associated with health risk.Individuals who are deaf or hard of hearing (D/HH), face a lower level of physical activity than other people. A reason might be the lack of auditive information during the physical activity and acommunication problem.Therefore, this study focuses on a review of the literature in order to identify the issues and measurement approachesof physical activity for individuals who are hearing impairedand deaf, and thus meet the inclusion criteria. The researchers identified 26 articles;but only 11 met the selection criteria. Findingsrevealedthat a questionnaire was the most preferred approach for measuring the physical activity of deaf and hearing-impairedindividuals of different ages. From the literature review, Cronbach's alphas coefficient was found to be widelyused to test reliability, while one study used test-retest.Among these studies reporting validity evidencecommonly used comparisons with normal hearing people. However, a number of methodological limitations relative to validity were observed. Given the importance of using multiple physical activity measures, only five (0.45) studies reported the use of multiple measures, and five (0.45) used a questionnaire. The findings are discussed relative to conducting future physical activity research on individuals who are deaf or hearing impaired.*

KEYWORDS*: Physical Activity, Physical Activity Measurement, Physical Activity Assessment, Hearing Impairments, Deaf.*

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I. INTRODUCTION

Physical activity has recently become a guideline for young people to engage in daily physical activity in 60 minutes of MVPA (Who, 2016; Who, 2010). The hearing level for people can be categorized based on the pure-tone frequencies of 500-400 Hz. Normal hearing and very slight level 0-25dB, would have ability to hear whispers; 26-40dB of slight hearing loss have the ability to hear words due to repeated normal voice with a distance of 1 meter. Another level of high hearing loss, such as moderate 41-60dB, and severe 61-80 dB, and profound, includes deafness of 81 dB or greater, which means being unable to hear even a loud shouted voice (Who, 2016).

The deaf and hearing impaired (D/HI) can enjoy physical activity but it has been reported that they are not particularly active (Ellis et al., 2014; Gispen et al., 2014; Kurková, 2016; Martin et al., 2013; Pelton, 2013). From the studies reviewed D/HI individuals can be categorized according to age levels, because the risk factors and measurement test parameters vary for different ages, for example, the physical activity levels differ from one age to another. There is a decrease in the number of steps with increase in age; this is because the number of steps for adults is less than number of steps for children as the latter should be more active.

Some studies which focused on the measurement of physical activity for D/HI children, showed limited participation and low frequency of activities compared with their typical peer (normal hearing) (Engel-Yeger & Hamed-Daher, 2013). The health of children is related to the value of physical activity, which implies that poor physical activity increases the possibility of health risk (Ellis et al., 2014). Children with disabilities in general have lower level of health related fitness than others because of the different factors that are in fact psychological, social and physical constraints (Lieberman et al., 2006). Parental influence may have a positive effect on their physical activity. It has been reported that parental influence can have a strong impact on the activity level of their children (Ellis et al., 2014). The psychological and socialproblems for individuals with hidden disabilities can reduce children's engagement in physical activity (Engel-Yeger & Hamed-Daher, 2013). Hearing impairments in children may delays development of various abilities such as cognitive and motor abilities as well as communication skills (Engel-Yeger, 2012).

On the other hand, adolescents have active friends and therefore engage in higher physical activity than others who do not have active friends. In the USA, a study on the predictable physical activity of adolescent deaf reported that boys with hearing impairments and normal hearing boys are similar, and enjoy activity with their close friends(Martin et al., 2013). Other studies of Chinese adolescents reported a link between physical activity and life satisfaction, which identified perceived physical appearance and self-esteem in both deaf and normal hearing adolescents as having a positive impact on engagement in physical activities (Lu et al., 2015).

Increased physical activity should increase self-efficacy, and individuals who do not participate in physical activities might do so if they perceive themselves capable of such activities(Barrett, 2015). The physical fitness level for deaf and hard of hearing (D/HH), might be lower than that of other people who have no disabilities. The problem of different levels of physical fitness might be due to lack of hearing ability and communication problems in the physical activity (Kurková, 2016). Adults who are deaf may have certain health issues as well as a problem with physical inactivity (Pelton, 2013). Decreased levels of physical activity have been associated with moderate or severe hearing impairment for older adults independent of other risk factors such as demographic and cardiovascular (Gispen et al., 2014). Therefore, there is need to seek new mechanisms for hearing impairments that can help to increase participation in physical activity (Gispen et al., 2014; Kurková, 2016).

There is also a need to promote better health in communities for the deaf, particularly among those who are physically inactive, in which case pedometers could encourage increased physical activity along with continual reinforcement (Pelton, 2013). Because of a lack of general awareness and understanding regarding the benefits of physical activity, the rate of engaging individuals who are deaf and hearing impaired in physical activity during leisure time its low compared to normal people. Therefore, it is necessary to investigate and understand the constraints of physical activity during leisure time for people who are D/HH. To enhance their lifestyle with physical activity. Toward this end, it is important to determine the factors that can prevent or facilitate physical activity for individual who are D/HH (Kurková, 2016).

The researchers have reviewed a number of existing methods used to examine physical activity for the purpose of assessing D/HI individuals in their physical activity. One of the reviews (Hinckson & Curtis, 2013) measured the physical activity for intellectually disabled individuals with different techniques and measurements to identify the strengths and weaknesses of the physical activity issues. This particular area of measuring the physical activity of D/HI individuals have been poorly researched.

The purpose of this study therefore is to extend the measurement for individuals who are D/HI, taking into account different age levels. We review the various methods of validated evidence and reliability used for measuring physical activity at different levels of hearing impairments and age.

II. MATERIALS AND METHODS

Primary searches were done through the search engines PubMed, BioMed, Scopus, Science Direct, WouldCate.The searches were for the purpose of identifying studies in which physical activityamonghearing impaired individuals was measured. The keywords used to detectrelevantarticles were"hearing impairments,"and "deafness."Each ofthe keywords was combined with"physical activity", "physical activity measurement","physical activity assessment", and exercise to locate the literature on the topic ofinterest for this review. This search yielded a total of 26 articles. Secondarysearches were also done by examining the reference sections of retrieved papersto detect other studies that might have been missed in either ofthe search engines.

Inclusion criteria:

Inclusion criteria comprised (a) English language articles whose primary and/or one of the main purposes was to measure physical activity among the hearing impaired andthe deaf, (b) studies in which a measure of physical activity was validated for a particular hearing impairments and deafness, (c) studies in which the target was hearing impairments and deafness, (d) studies in which physical activity data were reported, and (e) studies published from 2006 to 2017. Based on these criteria, 11 out of 26 articles met all inclusion criteria and were reviewed.

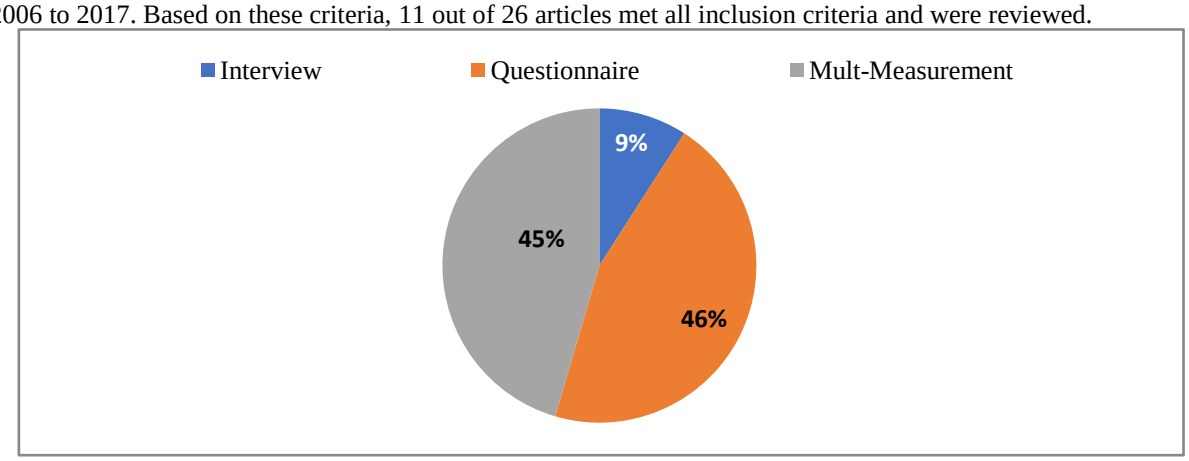

Figure 1: The percentage of distributed articles based on measurement approaches

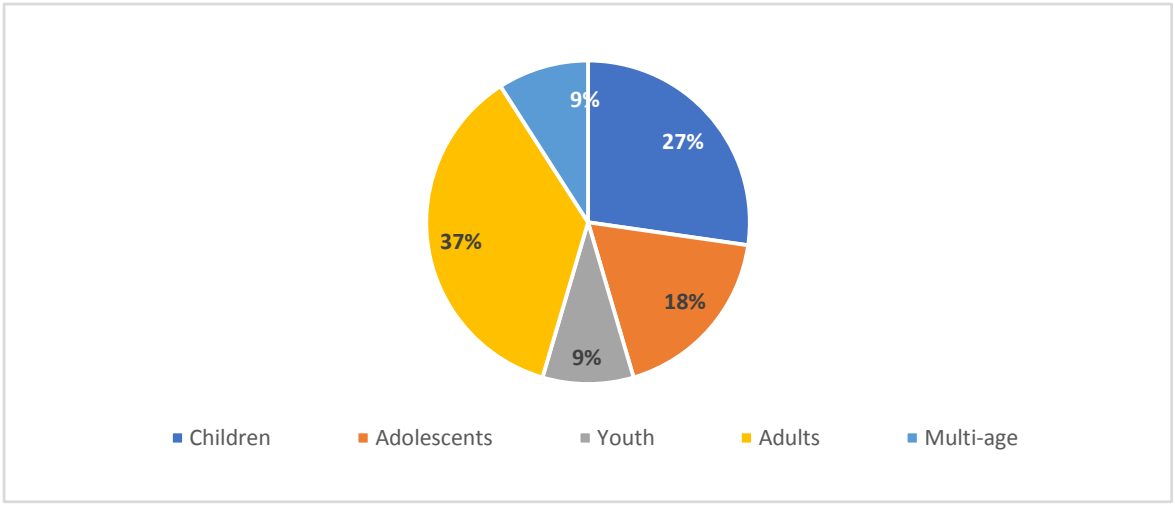

Figure 2. The percentage of distributed articles based on age level

Physical Activity Measurement: Fromthe review there was only one study usinginterview measurement (0.09) for deafness and hearing impairments, whilefive studies used questionnaire (0.46), and another five studies used multiple measurement(0.45)(Figure 1). The multiple measurement included:one interview and pedometer, one questionnaire and pedometer, one accelerometer and self-report, and one questionnaire with self-reports. One of these studies (0.09)included different levels of age (youths, adults and older age) of the hearing impairedand deaf. Just one studyfocused onyouth (0.09), while there were two for adolescents (0.18), fourfor adults (0.37), and three for children (0.27)(Figure 2).

Based on the review of the literature, there are limited studies on individuals who are D/HI. Therefore, make it is difficult for authors to identify the best approach for the measurement of physical activitylevels among the D/HI.

1. InterviewPhysical Activity

From the review one study used the Interview to measure physical activity for deafness and hearing impairments. It investigated the way physical activity in prevented or facilitated for older adults who are D/HH. The study identified four themes: 1) communication strategies; 2) visual and technical support; 3) environment; and 4) physical activity participation (Kurková, 2016). In the communication, the participants used speech, lip reading, and written texts. The participants without cochlea had difficulty understanding any written information (Ellis et al., 2014). Only four of eight who were D/HH did not have any difficulties in communication.

In visual and technical support, the authors, reported hearing aids being users to communicate and to control their surroundings. For the D/HH individuals, there were those who could hear sounds but they were not recognizable. The researchers recommended that instructors should modify their instructions during exercise and it was suggested that a suitable solution reported from the interviewees was to use graphic cards with simple labels and pictures to guide the exercise activity.

In the environment, it is important to take into account the current environmental lighting conditions, when providing information during physical activities. It may happen that information could be misunderstood due to fatigue or poor lighting conditions. Therefore, it necessary to be patient with under such conditions.

Despite these problems during exercise, all the participants expressed the belief that regular physical activity released them from their daily routine and helped to keep them in good mental and physical condition. They reported rediscovering the feeling a living a full life, like being able to safely walk the dog, among other activities.
Finally, confirmed that participation in physical activities is very important for all older adults who are D/HH in order to connect with existing mainstream community activities.

2. Questionnaire Physical Activity

From the review of the studies that met all inclusion criteria, five (0.46%) reported the use of questionnaire as the primary source of measuring physical activity behavior. Based on the studies included in this review, validity evidence was reported for the following groups: (a) Adolescents with hearing parents (Lu et al., 2015; Martin et al., 2013). (b) Children with three groups, both hearing parents, both deaf, and hearing/one deaf (Ellis et al., 2014), (c)Youth with hearing parents were from medium socio-economic level (Barrett, 2015), and (d) multiple age(youth, middle age, and old age) without considering the parents (Haas et al., 2016).

Both groups (a) and (b) focused on high level of hearing impairments and deaf, while group (c) focused on deaf only and group (d) focused on multiple level of hearing loss >25dB. All four studies reported criterion-related validity. In three of the studies, reliability was primarily reported as previously researched and reporting text.

3. Multiple Measurement

Given the known limitations of each of the existing physical activity measures, the use of multiple measures was proposed to provide a more comprehensive assessment of physical activity behavior (Bassett Jr, 2000; Dishman et al., 2001). This is on the basis of the rationale that by using multiple measures, one measure will compensate for the weakness of another.

Among the studies that met all inclusion criteria, only five (0.45%) reported using multiple measures to assess physical activity (see Table 1). These included a combination of (a) self-report, and accelerometers (Gispen et al., 2014); (b) questionnaire and self-report (Engel-Yeger & Hamed-Daher, 2013); and (c) questionnaire and pedometer (Pelton, 2013); (d) interview and pedometer (Lieberman et al., 2006). (e) questionnaire and accelerometer (Menezes et al., 2017). Most of these groups not considered parents instead the last group that considered parents without mention for hearing or not. Both groups (d, c) focused on deafness and group (b) focuses on moderate and greater, while groups (a) and (c) focused on multiple levels with one of them compared with normal.
Among these studies, two reported validity evidences (normal hearing and typical peers) for the measurement used, while one study reported pilot-test for validity evidence. In addition, two studies reported for validity evidence criterion-related for measuring the results. The reliability was measure specified in one study by Cronbach's Alphas (Pelton, 2013).

Participants in the studies using different age level for measuring physical activity included: three studies for adults, and two for children for one of the two measures used.

III. RESULTS AND DISCUSSION

From the review, measurement of physical activity for individual hearing impairment and deafness, the questionnaire measurements were widely used to assess the physical activity among individuals with deafness and hearing impairment. For consistency, the questionnaire used three of them for adults, two for adolescents and two for youths. In addition, two studies used questionnaire measurement for children by parents who helped to fill up the form. The advantages and disadvantages of the questionnaire for physical activity have been described and reviewed comprehensively elsewhere (Booth, 2000). However, researchers must take into account the concept and methodology when using questionnaire among the deaf and hearing impaired such as the age level.

In particular, for those who are deaf, the researchers used the questionnaire to identify the variables or risk. As a result, most of the studies for physical activity among D/HH used the questionnaire to study the relationships between variables or when comparing with normal people. Comparing the results of physical activity motivation between two methods used the International Physical Activity Questionnaires (IPAQ-S) and accelerometer, it was found that they were not significantly related (Menezes et al., 2017).

For those of older age, the researchers used self-reports as direct information although self-do not always get accurate information because respondents may not be active. Therefore, the researchers resort to using another measurement too such as an accelerometer or questionnaire for giving accurate information (Engel-Yeger & Hamed-Daher, 2013; Gispen et al., 2014).

In particular, researchers used the interview for those who had difficulty writing texts, or have difficulty understanding written text (Kurková, 2016). In addition, to understanding the risks of their surroundings, they also need to be aware of the risk of their physical activity. The interview was used with the deaf to understand the behavior of their trainer of coach to see if there is a better way for to facilitate and provide the activity. In the case of deaf-blind children a pedometer is used with the interview as a way to monitor and measure the daily steps and to study the walking behavior (Lieberman et al., 2006).

The pedometer and accelerometer are widely used to calculate step count as a direct observation of physical activity. These measurements, are used to achieve the objective of physical activity monitoring. Only four measurements have been reported using pedometer or accelerometer as alternative ways to compare the results of physical activity. Two of the studies endeavored to find risk factors for deafness and hearing impairments due to their physical activity (Gispen et al., 2014; Pelton, 2013).

The first study suggested using a pedometer as an alternative way to determine daily steps to validity the result on criterion-related basis and to study the effect of risk factors between men and women (Pelton, 2013). Another used an accelerometer with self-report to motivate the hearing impaired to increase their physical activity. The researchers suggested that the measurement of normal hearing people be used to validate the measurements of physical activity of the hearing impaired and risk factors effectiveness as a comparison (Gispen et al., 2014).

Overall, two studies have found to use ANOVA analysis as validity evidence to validate the variables with analysis multiple regression [3],[6] while another study used typical peers and normal hearing to compare the results as validity evidence in a second test (Engel-Yeger & Hamed-Daher, 2013; Gispen et al., 2014; Lu et al., 2015). Another three studies used validation measurements for criterion related or comparison results with other studies as validity evidence.

It was reported in the studies reviewed, that inter-instrument and Cronbach's alphas coefficient were widely used for reliability(Barrett, 2015; Lieberman et al., 2006; Martin et al., 2013; Pelton, 2013) while one study used test-retest to measure reliability.

However, some researchers failed to measure the to identify an adequate criterion for reliability or the sample has been not representative regarding the population [5],[7],[15]. The pilot study was used in one study to test the reliability of the instrument before it administered the questionnaire(Ellis et al., 2014). Another study used multiple scores which did not provide a single score for their correlation analysis which made it difficult to be specified [3],[6],[11],[14].

Source	Sample	Measure	Outcome Measurement	Validity	Reliability	Results
(Lieberman et al., 2006)	No = 22 children who are visually impaired or deaf-blind. Age = 10-12 years	Pilot-tested (Interview) Pedometer	Daily steps	Pilot-test	Interinstrument	Average steps for the girls (9,686) and boys (9,770) that the participants had lower levels of walking behavior than the recommended number of daily steps
(Martin et al., 2013)	No = 64 adolescents Hearing impaired Age = 14 years old	Questionnaires	Predict PA using social support	ANOVA analysis	Internal-consistency via Cronbach's Alphas Multiple scores,	Males and females receive social support from their friends who are most interested in physical education. American males with hearing Impairments or non-hearing impairments are similar,all of them enjoy physical activity if they are active with close friends.
(Pelton, 2013)	No = 105 adults deaf Just 87 completed pedometer data Age = 45 – 75+	Questionnaires Pedometer	Risk Daily steps	criterion-related	Inter-instrument	The risksthave been identified as obesity, stress reduction, cardiovascular disease And metabolic disease. Average 9-day pedometer step counts totaled 6,559 steps/day with a mean age of 69 years Men tend to walk more (mean=6,548 steps/day) than women (mean=5,044 steps/day), though the difference did not reach statistical significance
(Engel-Yeger & Hamed-Daher, 2013)	No = 25 children hearing impaired (moderate and greater) Age = 6–11 years	Questionnaire self-report	Compare pattern among visual and hearing impairments	Typical peers	Test–retest Ranging 0.67-0.81	Parent's education has significant effect on self-activities of hearing impaired, and the social demographic parameters included children age, parents education, socio-economic level have an effect on children PA
(Gispen et al., 2014)	No = 706 adults (Normal, moderate and grater) Age = 70 years or greater	self-reported accelerometer	Risk and measure leisure minutes of moderate-intensity physical activity	Normal hearing	Not reported	The risk factors identified demographic, cardiovascular and the results of accelerometer measurement 70% increase odds of low level while 59% increase odds of lower level physical activity comparing with normal hearing people. High level of hard hearing has less physical activity than lower level of hearing measured by self-report (OR=1.59, 95%CI: 1.11, 2.28) and accelerometer (OR=1.70, 95%CI: 0.99, 2.91).
(Ellis et al., 2014)	No = 128 children deaf Age = 8 years	Questionnaire	Pattern intiluence for physical activity and physical fitness levels	ANOVA Analysis	Pilot study Multiple scores,	Two deaf parents (M = 3.30, SD = 0.74) than two hearing parents (M = 2.65, SD = 0.64) the parents play an important role in physical activity for their children. Children who have both deaf parents have higher physical activity than those havinghearing parents.
(Barrett, 2015)	No = 146 youths deaf Age = 15–38 years	Questionnaires	Self-efficacy for multiple stage of PA	Standard of international guideline	internal-consistency $\alpha > 0.75$	Identified five stages according to transtheoretical model (TTM) theory, found the self-efficacy was higher in preparation stage compared with in action and maintenance stage,while the cons weremore, clear in in precontemplation stage.
(Lu et al., 2015)	No = 118 adolescents deaf Age = 15.12 years	Questionnaires	Relationships among perceived physical appearance, life satisfaction through self-esteem	Hearing peers	Multiple scores,	The results for relationship were partially mediated though self-esteem for deaf, while fully mediated through self-esteem for hearing. Self-esteemreliability $\alpha = 0.71$ for deaf adolescents, and $\alpha = 0.88$ for hearing adolescents
(Kurkova, 2016)	No = 8 adults (deaf or hard-of hearing) Age = 50+ years	Interview	Way of preventing or facilitating PA	Compared with other studies	Not reported	Identified four themes: communication strategies, visual and technical, support, environment, physical activity participation. The drawbacks of communication way have strongeffect on their physical activity.
(Haas et al., 2016)	1221 youth, adults, older (multiple level of hearing) Age = 21-94 years	Questionnaire	Relationships among measurement of PA	Compared with normal people	Multiple scores,	Relationship cannot be estimated due to nature of the cross-sectional, maybe we can say there is no significant relationship between PA and risk of hearing loss.
(Menezes et al., 2017)	No = 44 adults (severe and profound) Age = 18 - 65 years	Questionnaire, accelerometers,	Agreements method between (IPAQ-S and accelerometer)	Criterion-related (IPAQ-S)	Not specified	No statistically significant correlation for time spent in MVPA by using accelerometer and IPAQ-S. Moreover, no difference between the results finding for participationthat uses both measurements.

, Reader can refer multiple information

IV. CONCLUSION

Based on the review results, there is poor research on the physical activity of individuals who are deaf and hearing impaired. There is no real framework identified for D/HH, which involve individuals who received little attention. Most of the studies reported the criterion-related and previous research for validity evidence.

There is a lack of standard measurement for physical activity, it is important to consider physical activity measurement by assuming validity as a better quality of test or instruments that can be meaningful for decision making in measurement taken for a specific group. However, the researchers found limited agreement on validity measurement for physical activity for D/HI individuals. Unfortunately, researchers have failed to identify the validity evidence in some of their research. In this paper, the researchers assume that criterion-related has been provided for validity evidence of physical activity. Thus, there is no existing criterion measurement for measuring physical activity for the D/HH. This review has been limited to search with these search engines within the specific period from 2006-2017 as well as non-specified periods for better methods of physical activity for the deaf and hearing impaired due to few studies found. In future, there is a need to move from the traditional measurements as find new mechanisms to increase behavior of physical activity and monitoring by using new technology (Kadhum & Hasan, 2017).

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

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