Monitoring Physical Activity and Sleep Quality in Children with Blindness and Deafness: A Cross-sectional Study

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Abstract

Background

Child development has critical links to his ability to see and hear. When these senses are impaired, everything is impacted. The aim of this study was to investigate the effect of visual and hearing impairments on physical activity and sleep quality in a comparison with the normal sighted-hearing children.

Methods

This cross-sectional study included 60 Saudi children (20 blind, 20 sensorineural deaf, and 20 sighted-hearing) aged 10 to 15 years old. The physical activity levels and sleep quality were assessed using a waist-mounted ActiGraph accelerometer.

Results

Children with sensorineural deafness were significantly more active (in step rate and activity rate) than the sighted-hearing group (p = 0.05 and 0.003, respectively). Sighted-hearing children and children with blindness had significantly more sedentary time than children with sensorineural deafness (p = 0.004 and 0.03, respectively). Sleep efficiency was significantly higher in children with sensorineural deafness than sighted-hearing children (p = 0.02). No significant difference was recorded in any of the sleep parameters when children with blindness were compared to the sighted-hearing or children with sensorineural deafness (p > 0.05).

Conclusions

The ActiGraph results revealed that children with sensorineural deafness were significantly more active and with higher sleep efficiency than sighted-hearing children. Children with blindness spent more time in sedentary activities and less time in moderate activities than children with sensorineural deafness. There was no significant difference in sleep efficiency when comparing sensorineural deaf and blind children.

Background

Although all of our senses play a role in early development, vision and hearing seem the most important. A baby’s ability to make eye contact and to respond to his or her parents’ voices by gurgling, is considered the early bonding between the child and his parent [1, 2]. Infants typically attempt to move because they see or hear things that raise their curiosity. Infants learn about size, shape, color, and more just by listening and looking at the world. Early child development has critical links to the child’s ability to see and hear. When these senses are impaired, everything is impacted [2, 3].

In Saudi Arabia, visual impairment (VI) is a serious health problem, with a prevalence of more than 1.5% [4]. In 2012, the prevalence of hearing impairment (HI) in Saudi Arabia was estimated to be 1.75% [5]. Visual impairment or HI delay motor performance, which will affect physical activities [4–6]. Many research studies have separately investigated the effects of VI or HI on motor performance, but few studies have compared the impacts of these impairments [7].

Worldwide, an estimated 14 million children are blind. A child with visual loss is more likely to suffer from socioeconomic deprivation and developmental delay [8]. Visual impairment impacts all child development phases, especially learning and development of complicated motor skills. These skills are fundamental to a child’s social and emotional well-being as well as the overall life quality. Poorly developed motor skills lead to poorly performed physical activities and thus decreased the sense of competency. Furthermore, the locomotor control skills of the child, such as running and kicking, among children with blindness, are considered developmentally behind their sighted peers. Impairment of such skills results in withdrawal from activities requiring movement and subsequently limited opportunities for social participation and further practicing of
motor skills [9, 10].

Worldwide, about 440 million children have sufficient hearing loss to be classed as having a major disability, which leads to impaired development, and therefore handicaps. Hearing loss has significant subsequent difficulties in language and skills of communication along with impaired development of social and motor aspects [6, 11].

Motor skill development plays an important role in children's overall level of participation in physical activities. It has been reported that a strong relationship between children's motor skill development and participation in physical activities, especially moderate to vigorous physical activities [12–14]. Brunt and Broadhead [15] and Wiegarsma and Van der Velde [16] have studied the effects of HI on the motor development of children with deafness. They found that children with HI lag behind in motor skills. Many studies have reported that children with VI have lower levels of physical activity. Because of this reduced physical activity, children with VI have lower levels of health-related physical fitness and poorer body composition values compared to sighted-hearing children [17, 18].

Approximately 25% of children experience sleep disturbance during childhood [19]. In children with VI, this number is closer to 80% given that the sleep-wake rhythm is altered due to the lack of light perception [20, 21]. There are also few studies showing that sleep disturbances are common in individuals with HI. Dalton et al. [22] reported that sleep problems were as prevalent as 49.6% among individuals with HI.

This study aimed to investigate and compare the effects of VI and HI on physical activity and sleep quality in children. We hypothesized that both visual and hearing impairments would negatively affect physical activity and sleep quality in children. Also, children with VI will exhibit poorer physical activity and sleep quality than children with HI.

Methods

Study design

This study was a cross-sectional study with a descriptive analytic structure.

Participants

A convenience sample of 40 Saudi children (20 children with sensorineural deafness and 20 with blindness) participated in the current study. Twenty matching sighted-hearing children acted as a control group. The participating children were 10 to 15 years old from both genders. Participants were recruited from the primary and middle governmental and private schools in Eastern Province, Saudi Arabia (Fig. 1).

Inclusion criteria

Children with visual loss were healthy subjects with visual loss presented from birth and visual acuity less than 3/60 Snellen. Children with sensorineural hearing loss were healthy subjects with hearing loss presented from birth and thresholds of 90 Decibels and more. Sighted-hearing children were with normal hearing and vision, healthy subjects, and with no sensory disabilities.

Exclusion Criteria

Children of all groups were excluded if they: 1) Had neurological, mental, orthopedic, and physical impairments; 2) Who receive medications that weaken their muscles or affecting their balance and sleep such as anti-spastic, anti-epileptic, or sedative medications. Besides, children with hearing aids or cochlear implant were also excluded.

Procedures

The study procedures were carried out at the Physiotherapy Department at King Fahd Hospital of the University
in AlKhobar- KSA. Height, weight, and body mass index (BMI) were measured using a digital weight scale (Beurer BG 51 XXL diagnostic weight scale) and height scale (Health o meter Mechanical Beam Scale with Height Rod).

The participant’s physical activity levels and sleep were investigated using an ActiGraph (Bluetooth® Smart wGT3X-BT, US) accelerometer. The accelerometer is the most used objective method to assess children’s physical activity. The ActiGraph, which was used to measure the physical activity and sleep in the current study, is a small, light, and uniaxial device. The ActiGraph has been reported to have good reproducibility, validity, and feasibility in studies involving children and adolescents [23].

The ActiGraph was used to measure the wear and non-wear times, energy expenditure, physical activity counts and durations, and sleep parameters. The Acti-Life software (version 6.13.3) was used to process and analyze the participant’s data. In this study, the participant wears the waist-mounted ActiGraph wGT3X-BT accelerometer. The waist-mounted ActiGraph wGT3X-BT is a valid, reliable instrument for assessing physical activity at different intensities [24]. The participants were asked to wear a waist-mounted ActiGraph continuously for 4 consecutive days (during the week), removing it only during bathing. The minimal wear time should be not less than 2 days and lasting not less than 10 h/day [25]. To ensure compliance, the children’s parents received a call from the researcher.

When the participant returned the ActiGraph device, the researcher extracted the stored data to the computer for processing and analysis. Finally, from the participant’s clinical report, we recorded and utilized the wear and non-wear time information as total wear time, wear time per day, total non-wear time, and non-wear time per day [25]. The physical activity levels and durations data included total steps, total activity, total sedentary time, total light time, total moderate time, and total vigorous time [26, 27]. The sleep data included sleep efficiency, total time in bed, total sleep time, total wake time after sleep onset, the total number of awakenings, and total waking time of one awakening [28]. The different levels of physical activities used in this study are based on the physical activity categories from the equivalents and cut-off points proposed by Freedson et al. [29].

**Statistical analysis**

All analyses were carried out by using SPSS software (version 20.00; SPSS Inc, Chicago). Prior to analysis, all continuous variables (Age, anthropometric, physical activity, and sleep parameters) were checked for normality using the Shapiro-Wilk test as well as by observing the histogram and the Q-Q plot. Most of these variables were normally distributed. The non-normally distributed variables were subsequently square root transformed. Means and standard deviations were calculated. We used the one-way analysis of variance (ANOVA) followed by post hoc test (Least Significant Difference Test) to compare between the three groups.

It is important to mention that, there were significant differences between the three groups with respect to the ActiGraph wear time information. Therefore, during statistical analysis, we used the percentage and the rate of the ActiGraph parameters in spite of its absolute values.

**Results**

**Analysis of demographic and anthropometric characteristics**

Table 1 shows the demographic and anthropometric characteristics of all study participants (sighted-hearing, deafness, and blindness groups). The study participants were composed of 60 children (30 boys and 30 girls) with a mean age of 12.16 (1.58) years. No significant differences were found between the three groups for any of the demographic characteristics (age and gender) or anthropometric characteristics (all p-values > 0.05).
Table 1
Demographic and anthropometric characteristics of all study groups.

| Characteristics       | S-H  | Deaf   | Blind  | Sig (A) | Sig (B) | Sig (C) |
|-----------------------|------|--------|--------|---------|---------|---------|
| Number                | 20   | 20     | 20     | -       | -       | -       |
| Age (Years) (Mean/SD) | 12.55(1.6) | 11.70(1.59) | 12.25(1.55) | 0.09    | 0.55    | 0.27    |
| Gender (NO/%)         |      |        |        |         |         |         |
| ♂                     | 10/50| 10/50  | 10/50  | 1.0     | 1.0     | 1.0     |
| ♀                     | 10/50| 10/50  | 10/50  |         |         |         |
| Weight (Kg) (Mean/SD) | 43.6(9.75) | 37.0(7.4)  | 43.4(17.51) | 0.09    | 0.95    | 0.10    |
| Height (Cm) (Mean/SD) | 1.47(0.06) | 1.41(0.11) | 1.46(0.14) | 0.07    | 0.70    | 0.15    |
| BMI [Kg/(m)2] (Mean/SD)| 19.88(4.02) | 18.49(2.32) | 19.66(5.34) | 0.28    | 0.86    | 0.37    |

S-H: Sighted-hearing children; Sig (A): Significant difference between sighted-hearing children and children with deafness; Sig (B): Significant difference between sighted-hearing children and children with blindness; Sig (C): Significant difference between children with deafness and blindness.

*Significant difference (p ≤ 0.05).

Analysis of ActiGraph parameters

Wear time and non-wear time information

Table 2 shows the wear time and non-wear time of the ActiGraph in the three groups. There were no significant differences in ActiGraph wear time and non-wear time between the group with blindness and the sighted-hearing group, as well as between the groups with blindness and deafness (p > 0.05). When comparing the wear time and non-wear time in the deaf group with that in the sighted-hearing group, the wear time was significantly higher (p = 0.01) in the sighted-hearing group and the non-wear time was significantly lower (p = 0.01) in the sighted-hearing group.
Table 2
Comparing sighted-hearing children, children with deafness, and children with blindness with respect to wear time and non-wear time information of the ActiGraph (ANOVA/Post Hoc Test).

| Parameters                  | Groups         | Values (Minutes) (Mean/SD) | Difference (Minutes) (Mean) | Sig. | 95% Confidence Interval |
|-----------------------------|----------------|---------------------------|----------------------------|------|-------------------------|
| Total Wear Time             | S-H            | 4610(350)                 | 407                        | 0.01*| 98                      | 715          |
|                             | Blind          | 4336(491)                 | 73                         | 0.08 | -35                     | 582          |
|                             | Deaf-Blind     | -133                      | 0.39                       |      | -442                    | 175          |
| Average Wear Time Per Day   | S-H            | 921(70)                   | 81                         | 0.01*| 19                      | 143          |
|                             | Blind          | 867(98)                   | 54                         | 0.08 | -7                      | 116          |
|                             | Deaf-Blind     | -26                       | 0.38                       |      | -88                     | 34           |
| Total Non-Wear Time         | S-H            | 1150(350)                 | -407                       | 0.01*| -715                    | -98          |
|                             | Blind          | 1423(491)                 | -273                       | 0.08 | -581                    | 35           |
|                             | Deaf-Blind     | 134                       | 0.38                       |      | -174                    | 442          |
| Average Non-Wear Time Per   | S-H            | 230(70)                   | -81                        | 0.01*| -143                    | -19          |
| Day                         | Blind          | 284(98)                   | -54                        | 0.08 | -116                    | 7            |
|                             | Deaf-Blind     | 26                        | 0.38                       |      | -34                     | 88           |

S-H: Sighted-hearing children. * Significant difference (p ≤ 0.05).

Physical activity levels and durations

The physical activity data recorded by the ActiGraph is presented in Table 3, including step rate, activity rate, and percentage of total activities time. The deaf group was significantly more active than the sighted-hearing
group in terms of step rate and activity rate (p values 0.05 and 0.003, respectively). Moreover, children with HI spent more time in light and moderate tasks as compared with their sighted-hearing peers (p = 0.004 and 0.02, respectively). The sighted-hearing group and the blindness group had significantly more sedentary time than the deafness group (p = 0.004 and 0.03, respectively).

Table 3
Comparing sighted-hearing children, children with deafness, and children with blindness with respect to physical activity levels and durations measured by the ActiGraph (ANOVA/Post Hoc Test).

| Parameters                        | Groups               | Values (Mean/SD) | Difference (Mean) | Sig.   | 95% Confidence Interval |
|-----------------------------------|----------------------|------------------|-------------------|--------|-------------------------|
|                                   |                      |                  |                   |        |                         |
|                                   |                      |                  |                   |        | **Lower**               | **Upper**               |
| **Step Rate (step/min)**          | S-H                  | 6.36(1.97)       |                   |        |                         |
|                                   | Deaf                 | 7.93(2.91)       | -1.56             | 0.05*  |                         |
|                                   | Blind                | 6.79(2.61)       | -0.43             | 0.59   |                         |
|                                   | **Deaf**             |                  |                   |        |                         | -3.17                  | 0.03                   |
|                                   | **Blind**            |                  |                   |        |                         | -2.03                  | 1.17                   |
|                                   | **S-H**              |                  |                   |        |                         | -0.46                  | 2.73                   |
| **Activity Rate (activity/min)**  | S-H                  | 1033.8(287.9)    |                   |        |                         |
|                                   | Deaf                 | 1383.0(436.9)    | -349.1            | 0.003* |                         |
|                                   | Blind                | 1170.9(321.9)    | -137.0            | 0.22   |                         |
|                                   | **Deaf**             |                  |                   |        |                         | -573.7                 | -124.5                 |
|                                   | **Blind**            |                  |                   |        |                         | -361.6                 | 87.5                   |
|                                   | **S-H**              |                  |                   |        |                         | -12.5                  | 436.7                  |
| ***Percentage of Total Sedentary Time (%) | S-H                  | 67.93(6.96)      |                   |        |                         |
|                                   | Deaf                 | 60.18(10.62)     | 7.75              | 0.004* |                         |
|                                   | Blind                | 65.73(6.24)      | 2.20              | 0.39   |                         |
|                                   | **Deaf**             |                  |                   |        |                         | 2.58                   | 12.93                  |
|                                   | **Blind**            |                  |                   |        |                         | -2.97                  | 7.37                   |
|                                   | **S-H**              |                  |                   |        |                         | -10.72                 | -0.38                  |
| ***Percentage of Total Time in Light Activities (%) | S-H                  | 15.08(2.9)       |                   |        |                         |
|                                   | Deaf                 | 18.23(4.13)      | -3.14             | 0.004* |                         |
|                                   | Blind                | 16.59(2.83)      | -1.50             | 0.16   |                         |
|                                   | **Deaf**             |                  |                   |        |                         | -5.26                  | -1.02                  |
|                                   | **Blind**            |                  |                   |        |                         | -3.62                  | 0.61                   |
|                                   | **S-H**              |                  |                   |        |                         | -0.47                  | 3.76                   |
### Percentage of Total Time in Moderate Activities (%)

|       | S-H     | Blind   | Deaf  | Blind  |
|-------|---------|---------|-------|--------|
|       | 16.65(4.76) | 17.35(5.10) | 3.82  | 0.05*  |
|       | -4.52   | 0.72    | -0.07 | 0.50   |
|       | 0.02*   | -4.59   | -0.06 | 0.15   |
|       | -8.42   | 3.19    | 7.72  |        |

### Percentage of Total Time in Vigorous Activities (%)

|       | S-H     | Deaf   | Bladn  |
|-------|---------|--------|--------|
|       | 0.30(0.27) | 0.37(0.42) | 0.31(0.35) |
|       | -0.07   | 0.50   | -0.01 |
|       | 0.50    | -0.30  | 0.87   |
|       | -0.30   | 0.20   | -0.24 |
|       | 0.15    | 0.28   | 0.28   |

S-H: Sighted-hearing children. * Significant difference (p ≤ 0.05). ** Step and activity rate were calculated by dividing the number of steps or the number of activities by the total wear time. *** All percentages were calculated as a percentage from the total wear time.

**Sleep parameters**

All sleep parameter results measured by the ActiGraph are presented in Table 4. When the deaf group was compared with the sighted-hearing group, the sleep efficiency was significantly higher in the deaf group (p = 0.02). Also, the percentage of total wake time after sleep onset and the awakening rate were significantly higher in the sighted-hearing group (p = 0.02, and 0.01, respectively). These findings support the claim that sleep quality was significantly better in the deaf group compared to the sighted-hearing group. On the other hand, no significant difference was recorded in any of the sleep parameters when the group with blindness was compared to the sighted-hearing group or the deaf group (p > 0.05).
Table 4
Comparing sighted-hearing children, children with deafness, and children with blindness with respect to sleep parameters measured by the ActiGraph (ANOVA/ Post Hoc Test).

| Parameters | Groups | Difference (Mean) | Sig. | 95% Confidence Interval |
|------------|--------|-------------------|------|-------------------------|
|            |        |                   |      | Lower | Upper                  |
| ** Sleep Efficiency (%)** |        |                   |      |        |                        |
| S-H 94.18(1.91) | **Deaf** 96.03(2.79) | -1.85 | 0.02* | -3.48 | -0.22                  |
| S-H 94.18(1.91) | **Blind** 94.70(2.88) | -0.51 | 0.52 | -2.14 | 1.10                   |
| ** Deaf** Blind | 1.33 | 0.10 | -0.29 | 2.96 |
| *** Percentage of Total Wake Time After Sleep Onset (%)** |        |                   |      |        |                        |
| S-H 5.44(1.97) | **Deaf** 3.81(2.40) | 1.62 | 0.02* | 0.21 | 3.04                   |
| S-H 5.44(1.97) | **Blind** 4.35(2.28) | 1.09 | 0.12 | -0.31 | 2.50                   |
| ** Deaf** Blind | -0.53 | 0.45 | -1.94 | 0.87 |
| **** Awakening Rate (number of awakenings/hour) |        |                   |      |        |                        |
| S-H 1.09(0.36) | **Deaf** 0.75(0.47) | 0.33 | 0.01* | 0.05 | 0.60                   |
| S-H 1.09(0.36) | **Blind** 0.88(0.44) | 0.20 | 0.13 | -0.06 | 0.48                   |
| ** Deaf** Blind | -0.12 | 0.36 | -0.39 | 0.14 |
| Average Total Wakening Time of one Awakening (minutes) |        |                   |      |        |                        |
| S-H 2.97(0.36) | **Deaf** 3.06(0.52) | -0.09 | 0.58 | -0.43 | 0.21                   |
| S-H 2.97(0.36) | **Blind** 2.85(0.66) | 0.11 | 0.50 | -0.22 | 0.45                   |
| ** Deaf** Blind | 0.20 | 0.22 | -0.13 | 0.54 |

S-H: Sighted-hearing children. * Significant difference (p ≤ 0.05). ** Sleep Efficiency = (Total Sleep Time) / (Total Time in Bed) x 100. *** Percentage of Total Wake Time after Sleep Onset = (Total Wake Time after Sleep Onset) / (Total Sleep Time) x 100. **** Awakening Rate (awakenings/hour) = (Total Number of Awakenings) / (Total Sleep Time (minutes)) x 60.
WHO recommended that the duration of physical activities in children and youths aged 5-17 years old should be a minimum of 60 min of moderate to vigorous tasks per day and that this could be divided into short bouts throughout the day. Whenever possible, children and youth with disabilities should meet these recommendations [30]. All participants in the current study did not meet these WHO recommendations.

Although the activity rate of the children with deafness in this study was slightly higher than that of the children with blindness, this did not reach statistical significance (p = 0.06). These results were in contrast with the findings reported by Engel-Yeger and Hamed-Daher [31], who detected significant differences in the activity performance between children with HI and VI; children with VI performed fewer activities than children with HI. This lack of consensus in the literature regarding activity rate might be due to the different physical activity assessment methods used in these studies.

In this study, when comparing children with HI to sighted-hearing children regarding their step rate and activity rate, significant differences were noticed in favor of children with HI (p = 0.05 and 0.003 respectively). In general, children with HI had lower sedentary time and higher time in light and moderate activities than their sighted-hearing peers (p = 0.004, 0.004, and 0.02 respectively). No significant differences were recorded between the three groups with respect to the total vigorous activity time. Our study results were consistent with the outcomes from the work of Longmuir and Bar-Or [32], where children with HI were considered to be more fit or as fit as sighted-hearing children. Gispen et al. [33] found that adults with HI had less physical activities than adults without HI. These differences in physical activity parameters between the group with HI and the sighted-hearing group might be due to the different age groups in the research.

In addition, all children in this study were at school during physical activities assessment, and this could be the reason why all children spent most of their time in sedentary activities, with the percentages of total sedentary time between 60.18 ± 10.62 and 67.93 ± 6.96. These results were consistent with a study done by Sit et al. [34], which reported that children spent more than 70% of their overall time at school being sedentary.

However, the current research showed that children with VI spent more time in sedentary activities compared with children with HI (65.73 ± 6.24% in VI vs. 60.18 ± 10.62% in HI, p = 0.03). Our findings are consistent with those reported by Longmuir and Bar-Or [32]. These authors found that most youths with VI had relatively limited participation in physical activity compared to children with HI. Sit et al. [34] reported that children with VI were more active and spent less time sedentary than children with other disabilities, including HI. These conflicting findings might be due to the variety of lifestyle characteristics in the school system in Hong Kong, where the Education Bureau recommends that 5-8% of the total school curriculum time be allocated to daily active physical education.

Also, children with HI showed better sleep efficiency, less wake time after sleep onset, and a lower awaking rate when compared to the control group. However, no significant differences were reported for sleep parameters when comparing children with VI and sighted-hearing children, nor when comparing children with VI and children with HI.

Dursun et al. [35] investigated the effect of ice skating on the sleep quality in children with VI and HI using the Pittsburgh Sleep Quality Index (PSQI) questionnaire. These authors found that children with HI had poorer sleep quality than children with VI before and after the ice skating program. These controversial results in sleep quality might be due to the different quality of sleep assessment methods.

A study on toddlers with VI by Fazzi et al. [20] also showed that in the first years of life, children with VI had increased risk for a specific sleep disorder compared with their sighted peers. In addition, Davitt et al. [36] studied sleep disorders in children with congenital Anophthalmia and Microphthalmia and found that children with VI had more sleep disorders compared to sighted-hearing children. These controversial results in sleep quality of VI children might be due to the difference in sleep assessment methods and/or the difference in age of the involved children.
Limitations

The current study has some limitations. First, the sample in this study was a convenience sample of children with sensorineural deafness and blindness which might encourage bias. Second, the current study was unblinded, which might also introduce bias. Third, all participants were recruited only from schools in the Eastern Province and this could affect the generalizability of the obtained results to the whole Kingdom. Therefore, the results of the study should not be generalized, except with great caution. Last, the physical activity evaluation via the ActiGraph accelerometer was assessed for only 4 days; the results might have been more representative if this had been done for 7 days.

Conclusions

This study determined the consequences of blindness and deafness on physical activity and sleep quality which will help practitioners address these possible impairments. It is clear that vision and hearing play significant roles in early child development. Our findings show that blindness adversely influences child physical activities and sleep quality. Children with blindness spent more time sedentary and less time in moderate activities than children with sensorineural deafness. Children with sensorineural deafness had a higher step rate and activity rate than their sighted-hearing peers. Also, children with sensorineural deafness spent less time sedentary and more time in moderate activities compared to sighted-hearing children and children with blindness. The sleep efficiencies in children with sensorineural deafness and blindness were similar. However, children with sensorineural deafness had better sleep efficiency when compared with their sighted-hearing peers.

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Board Committee, Deanship of Scientific Research at Imam Abdulrahman Bin Faisal University, Saudi Arabia, with IRB number (PGS-2018-03-169). All parents of our study participants gave their informed consent.

Consent for publication

Informed consent was obtained from all participants included in the study.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare no conflict of interest.

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Author contributions

R. A. and A. I. were involved in the study design, data collection, and data analyses. T. A. was involved in supervision and project administration. All authors were involved in writing and revising the manuscript. All authors read and approved the final manuscript.

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Assessed for eligibility (n=68)

Enrolled (n=64)

Allocation
- Allocated to children with sighted-hearing (n=20)
- Allocated to children with deafness (n=21)

Follow-Up
- Incompliance with ActiGraph wear time (n=0)
- Incompliance with ActiGraph wear time (n=1)
Figure 1
Participants’ Flowchart.