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ORIGINAL ARTICLE

# Activity-Based Cost Analysis of Speech-Language Therapy Services: A Comparison between Conventional Therapy versus Teletherapy For Paediatric Population

FATIMAH HANI HASSAN[1]*, NEOH ZHI JIA[2], SUSHEEL JOGINDER SINGH[1], AMALINA SYAZANA ADNAN[1], SITI MUNIRAH HARIS[1], HAFIZAH MOHD AZRAAI[1], NABIHAH ISMAIL[3]

[1]*Center for Rehabilitation and Special Needs Studies, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, 53200 Kuala Lumpur, Malaysia*

[2]*Department of Speech Therapy, Pacific Speech Therapy and Learning Centre, 11600 Georgetown, Penang, Malaysia*

[3]*Integrated Healthcare Department, PERKESO Tun Abdul Razak Rehabilitation Centre, 75450 Melaka*

**Correspondence: fatimahhani@ukm.edu.my; Tel: +603 92895014*

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***ABSTRAK***

*Analisis kos berasaskan aktiviti merupakan piawai emas dalam penilaian ekonomi. Walaupun terdapat laporan terdahulu mengenai kos perkhidmatan penjagaan kesihatan secara konvensional dan juga perkhidmatan secara maya, kajian yang melaporkan kos perkhidmatan terapi pertuturan-bahasa masih terhad, khususnya kajian yang membandingkan kos terapi pertuturan-bahasa konvensional dengan teleterapi. Kajian ini dijalankan untuk membandingkan kos yang ditanggung oleh penjaga, pelajar klinikal (SC) dan institusi perkhidmatan (Universiti Kebangsaan Malaysia) bagi program intervensi pertuturan-bahasa di klinik universiti yang dilaksanakan melalui sesi bersemuka secara konvensional dan telesesi. Seramai 18 pasangan penjaga-SC telah direkrut dalam kajian. Semua aktiviti terapi dan bahan yang digunakan dalam setiap sesi terapi dikodkan dan dianalisis menggunakan borang kos mikro. Kos pentadbiran turut didokumentasikan. Secara keseluruhan, kos terapi bersemuka adalah lebih tinggi berbanding teleterapi. Walau bagaimanapun, perbezaan kos hanya signifikan bagi penjaga dan SC. Penemuan ini berguna dalam menentukan pendekatan penyampaian perkhidmatan serta sokongan kepada pengguna perkhidmatan.*

***Kata kunci:*** *Analisis kos; telerehabilitasi; terapi pertuturan-bahasa*

**ABSTRACT**

Activity-based cost analysis is a gold standard in economic evaluation. Despite reports on the costs of conventional and virtual healthcare services, limited studies demonstrated the costs of speech-language therapy services, especially those comparing the costs of conventional speech-language therapy versus teletherapy. This study aims to compare the costs invested by caregivers, student clinicians (SCs) and the service institution (Universiti Kebangsaan Malaysia) for speech-language intervention programs at the university that were delivered via conventional face-to-face sessions and telesessions. A total of 18 caregiver-SC dyads were recruited. All therapy activities and materials used in each therapy session were coded and analysed using a micro-costing form. Administrative costs were also documented. Overall, face-to-face therapy costs higher than teletherapy. However, cost differences were only significant for the caregivers and SCs. These findings are useful in determining service delivery approaches and support for service consumers.

**Keywords:** Cost analysis; speech-language therapy; telerehabilitation

## INTRODUCTION

The evaluation of healthcare costs is important in the decision-making process at multiple levels, including at the level of service providers, service recipients, administrators and policymakers to identify social and economic determinants of health and how the factors may impact the delivery of healthcare services (Ku Abd Rahim et al. 2020). Outcomes of cost analysis are often useful in enhancing service delivery methods or processes, based on evidence that supports alternative approaches (Zailani et al. 2021).

Activity-based costing (ABC) is a method for deriving costs that have been incurred from the provision of goods and services to consumers (Ibrahim et al. 2018). It is a type of economic evaluation method that was proposed to provide the best estimates of costs, including in the healthcare sector (Zailani et al. 2021). ABC consists of detailed value calculation for each component of service delivery based on specific activities involved throughout the service delivery process (Ibrahim et al. 2018). In measuring the costs of health and medical services, the ABC method considers overhead expenses and costs of a procedure across a full longitudinal care cycle.

Following the COVID-19 pandemic and the restrictions imposed on the public in their movements, teletherapy has been adopted throughout the world to ensure continuous access to speech-language services for individuals across the lifespan. At Universiti Kebangsaan Malaysia (UKM), the Speech Sciences Clinic began to provide speech-language interventions through teletherapy during the pandemic period as an alternative to the conventional speech-language therapy that has been conducted in a face-to-face manner (Ahmad Rusli et al. 2021). The purpose of adopting this alternative was to ensure the accessibility of speech-language services to patients, as well as the continuation of training for students who are enrolled in the Speech Science degree program at the university. Following the experience, teletherapy has transformed into an essential component of clinical services and student training at the UKM Speech Science Clinic. In both modes of therapy, caregivers were expected to take part in the intervention sessions to ensure carryover of goals from the clinical setting to their homes.

In a prior evaluation of patient satisfaction, teletherapy was found to elicit a similar satisfaction level as compared to conventional speech-language therapy (Hassan et al. 2023). It was also found that patients' income contributed to their level of satisfaction with speech-language services that were delivered via face-to-face (conventional) and virtual (teletherapy) methods. However, no other indicators of service delivery evaluation were included in that study. The study also focuses on the perspectives of patients without considering the experience of service providers (including student clinicians and qualified clinicians/clinical supervisors).

Program evaluation may be evaluated from an economic angle (Rossi et al. 2018). In Malaysia, several studies have been conducted to determine the costs of various medical procedures and treatments in a variety of settings. For example, Jalalabadi et al. (2018), conducted ABC analysis on different radiological procedures at a public university hospital to determine the estimated costs of each component of procedures and develop guidelines for reducing wasted resources. They suggested that their findings improve the efficiency of patient management.

In a more recent study, Abdul Aziz et al. (2020) compared the costs of an integrated care pathway for stroke management. The study applied a combination of top-down and ABC approaches, in which the cost of care in 10 public primary care facilities was analysed from the societal perspective that included healthcare providers, stroke patients and caregivers, as well as the administrative perspective, in which estimated capital and recurrent costs were taken into consideration. Abdul Aziz et al. (2020) reported that the integrated care pathway was more cost-effective as compared to the conventional care approach.

In the field of speech-language therapy, Coppess et al. (2019) measured the costs of different treatment procedures for swallowing

disorders offered by speech-language therapists. They placed monetary values on all objective and subjective measures indexed by patients and providers, as well as specific activities conducted during treatment. Based on their findings, Coppess et al. (2019) suggested a value-based model of care for swallowing management. The study demonstrated the potential application of economic approaches for evaluating the effectiveness of speech-language intervention. In a more recent study, Völter et al. (2021) measured and compared the costs comparing telerehabilitation versus face-to-face rehabilitation for individuals who receive cochlear implants. Data on costs covered by the healthcare centers and patients were included. They found an economic difference between intervention mode, where telerehabilitation offered a cost-effective solution.

Previously, cost analysis has been conducted to estimate the cost of student-led programs and services in different parts of the world, but not in the field of speech-language therapy. Stickler et al. (2017) conducted a cost analysis on a student-run, free physical therapy service to estimate the amount of investment for the program. In this study, monetary cost and benefit were quantified and presented to program stakeholders and community members who benefit from it. In a different study, Hua et al. (2015) measured the costs of podiatric treatment provided by medical student volunteers at a public university. Hua et al. (2015) identified estimates of annual management costs, which helped the program administrators to determine the potential establishment of additional student-run clinics. Both studies showed the benefit of cost analysis for identifying the extent of investment and potential programs that may support student development to become healthcare professionals.

To date, no study has reported outcomes of cost analysis for speech-language services in Malaysia. Despite a substantial uptake of telerehabilitation in the field, especially during the COVID-19 outbreak, analysis of telerehabilitation costs remains unestablished. Additionally, the cost of student training in speech-language therapy has not been clearly identified. The present study aimed to determine the costs invested by caregivers, student clinicians (SCs) and clinic administration for a student-led, speech-language intervention program, and to compare the investment costs between conventional face-to-face speech-language therapy versus teletherapy. It was hypothesised that the cost of speech-language intervention was significantly higher for conventional face-to-face speech-language therapy than teletherapy. The costs between speech-language therapy modes were expected to differ across different stakeholders, including caregivers, student clinicians and the university.

## MATERIALS AND METHODS

### Participants

Recruitment of participants began after ethical approval was granted by UKM Research Ethics Committee (approval reference no: JEP-2020-109). This study involved individuals who fit the following inclusion criteria. For caregivers included in the study, they were: (i) parents who were the primary caregivers of their children with speech and/or language disorders; (ii) newly enrolled in the student-led speech-language therapy program at the UKM's Audiology and Speech Science Clinic; and (iii) involved in the weekly speech-language therapy sessions for eight consecutive weeks. Purposive sampling method was employed in the recruitment of participants. For student clinicians, they were: (i) UKM undergraduate students enrolled in the Speech Science Program; (ii) in their Year 3 or Year 4 of their studies; and (iii) leading the speech-language therapy sessions for children whose parents had agreed to take part in this study. Each caregiver and student participant provided individual consent for participation. Throughout those eight weeks, all participant dyads were involved in both forms of therapy (i.e., conventional face-to-face therapy and teletherapy), where each form of therapy was conducted at least once out of those eight therapy sessions. All student-led therapy sessions were supervised by qualified speech-

language therapists cum clinical instructors with a minimum of three years of working experience in the field.

**Research Tools and Materials**

A background information form was developed for recording participants' background information (e.g., age, gender, race and caregivers' occupation). The background information form also included a section with close-ended questions to identify caregivers' perceptions regarding speech-language services and intervention costs, as well as their preference for speech-language service delivery methods.

A micro-costing form was also developed based on published literature. The micro-costing form was adapted from Abdul Aziz et al. (2020) straight-line deprecation with a discount rate of 3% was assumed for calculation of equivalent annual costs for building and machines. Cost of electricity was calculated by multiplying number of kilo watts used by electrical appliance in the year 2010 with electricity tariff for Malaysian commercial consumers (MYR 0.31 per kWhand Jalalabadi et al. (2018). The micro-costing form (Supplementary Material) consisted of two sections: Resources and Clinical Activities. The Resources section included items related to human resources (e.g., clinical supervisor, overhead costs) and physical resources (e.g., capital costs), while the Clinical Activities section included items related to intervention materials (e.g., toys) and consumables (e.g., paper, pen, apron).

Recorded videos were used for completing the micro-costing form. Video recordings were conducted on one conventional therapy session and one teletherapy session. All conventional therapy sessions were recorded using the UKM Audiology and Speech Science Clinic's closed-circuit television facility, and the teletherapy sessions were recorded using the Zoom software, version 5.13.2022 (Zoom Communications, Inc., San Jose, CA, USA) recording function.

**Procedure**

Recruitment posters of the study were distributed to the clinical instructors and student clinicians to assist identification of potential caregiver participants. In addition, the posters were displayed at the UKM Audiology and Speech Science Clinic registration counter, Facebook and Instagram pages. The study information was extended to potential caregivers of children with communication disorders. After obtaining the consent form from both student and caregiver participants, recorded videos were obtained from the participating student clinicians. The caregiver participants completed the background information form.

Based on the recorded videos, the micro-costing form was completed for all activity-based costs. Monetary value was allocated for each coded activity and material through participants' self-reports during individual interviews. A structured interview approach was employed to verify the monetary value by recalling the cost of different materials used. Student participants verified the monetary value of each material used during therapeutic activities. For caregiver participants, therapy fees were verified. For both student and caregiver participants, the monetary value was also allocated for direct non-therapeutic costs, such as transportation and meal expenditures, when attending a clinical session. All values were included in the micro-costing form. Participants did not provide receipts to specify the cost of materials and other expenses.

Additionally, the financial management of the clinic was verified by the university's administrative personnel. For Human Resources and Physical Resources sections, direct costs and indirect costs covered by the Faculty of Health Sciences for running the services at the UKM Audiology and Speech Science Clinic were identified. The direct costs included consumables, intervention materials and devices, human resources (e.g., clinical supervisors and other staff) and online platforms for teletherapy, while indirect costs included capital and overheads.

**Data Analysis**

The micro-costing form was used to record all activities conducted in each therapy session based on the videos, including playing with toys, sharing books, creating arts and crafts, and providing recommendations to parents. For each activity, materials used were identified, such as cooking set, toy animals, stationery and digital devices (e.g., tablet and laptop). A total of 10% of the video samples were randomly selected and coded independently by a different research team member. The inter-coder agreement was conducted and reached a 90% agreement between two independent coders. All discrepancies were resolved between the two coders. All coded activities and materials were allocated a monetary value as reported by the participants during individual interviews.

All coded data were transferred to the Statistical Packages for the Social Sciences (SPSS) version 25.0 (IBM Corp, Armonk, NY, USA). Descriptive analysis was conducted for demographic information and all cost-related data. Results were shown as means, standard deviations (SD) and ranges for continuous variables and frequencies and percentages for categorical variables. Wilcoxon signed rank test for paired samples was applied to compare the total intervention costs between conventional therapy and teletherapy. All the costs were calculated in Malaysian Ringgit (RM). The cost of intervention materials was annualised over the useful life years of one year with a 10% discount rate (annualisation factor: 0.909), and the cost of equipment was annualised over five years with a 10% discount rate (annualisation factor: 3.791). The equivalent annual cost for each item was calculated based on the following equation:

Annual cost = Net value of the item (Purchase value) / Annualisation factor

Human resource costs were calculated by converting the salary of each employee into salary per minute (MYR/min) by assuming a daily working time of 8 hours and a monthly working time of 20 days. The cost of each employee per single therapy session was obtained by multiplying the employee's salary per minute (MYR/min) by the time spent in a therapy session. The duration of each therapy session ranged from 35 to 60 minutes.

## RESULTS

**Background of Caregiver Participants and their Perceptions about Different Therapy Modes**

A total of 18 dyads were recruited in the study, including 18 caregivers and 18 student clinicians. Table 1 showed the background of caregiver participants. The caregiver participants' ages ranged from 30 years to 67 years, with a mean age of 37.9 years (standard deviation, SD = 7.8). All caregiver participants were below 45 years old, except for one participant (P09 who was 67 years old). The caregivers were predominantly women (n = 17, 94.4%) and of Malay ethnicity (n = 14, 77.8%). Speech-language therapy was given to their children who were primarily pre-schoolers between 4 and 6 years old (n = 11, 61.1%). Their mean monthly household income ranged from RM2,500.00 to RM16,000.00, with a mean income of RM8,222.22 (SD = RM3,885.20). Twelve caregiver participants (66.6%) reported a monthly household income within the M40 category.

Caregiver participants reported the highest preference for conventional speech-language therapy mode (n = 12, 66.7%) and perceived that conventional mode of speech-language therapy gave the best outcomes to their children (n = 12, 66.7%). Conventional speech-language therapy was also perceived to be the most expensive mode of service delivery for speech-language therapy by most caregivers (n = 15, 83.3%).

**Comparisons of the Cost of Conventional Speech-language Therapy versus Teletherapy**

A Wilcoxon signed rank test for paired samples revealed that there was a significant difference

TABLE 1: Background information and perceptions of caregivers about different therapy modes

| Participant background | n (%) |
|---|---|
| Caregiver's ethnicity | |
| Malay | 14 (77.8) |
| Chinese | 4 (22.2) |
| Caregiver's gender | |
| Female | 17 (94.4) |
| Male | 1 (5.6) |
| Monthly household income | |
| B40 | 3 (16.7) |
| M40 | 12 (66.6) |
| T20 | 3 (16.7) |
| Preference for speech-language therapy modes | |
| Conventional mode only | 12 (66.7) |
| Teletherapy only | 0 (0.0) |
| Hybrid mode | 6 (33.3) |
| Perception about the mode with the best intervention outcomes | |
| Conventional mode only | 12 (66.7) |
| Teletherapy only | 1 (5.6) |
| Hybrid mode | 5 (27.8) |
| Perception about speech-language therapy modes with the highest expenditure | |
| Conventional mode only | 15 (83.3) |
| Teletherapy only | 1 (5.6) |
| Hybrid mode | 2 (11.1) |

for all comparisons between the costs of conventional speech-language therapy and teletherapy. As shown in Table 2, the comparison between the total costs revealed a significantly higher expenditure for a conventional speech-language therapy session valued at RM142.72 per session as compared to teletherapy valued at RM84.14 ($z = 3.80$, $p = 0.00$, $r = 0.71$). Higher cost for the conventional mode was also found based on the expenditure of caregivers ($z = 3.65$, $p = 0.00$, $r = 0.53$) and SCs ($z = 3.72$, $p = 0.00$, $r = 0.65$). For caregivers, the median cost of a conventional speech-language therapy was valued to be RM41.50, which was higher than teletherapy valued at RM13.25. For SCs, the median cost of conventional speech-language therapy was RM17.18, compared to RM0.10 for teletherapy. However, there was no significant difference in the cost of conventional speech-language therapy versus teletherapy borne by the

TABLE 2: Comparison of intervention costs (based on median values) between conventional therapy and teletherapy (per session)

| | Conventional (RM) | Teletherapy (RM) | z | p | r |
|---|---|---|---|---|---|
| Cost of speech-language therapy | | | | | |
| Total | 128.28 | 81.90 | 3.80 | 0.00 | 0.71 |
| Caregiver | 41.50 | 13.25 | 3.65 | 0.00 | 0.53 |
| Student clinician | 17.18 | 0.10 | 3.72 | 0.00 | 0.65 |
| Clinic administrator | 56.18 | 56.19 | 0.84 | 0.10 | 0.14 |

p: significance p- values; r: effect size; z: statistical z-scores

university for clinical administration ($z = 0.84$, $p = 0.10$, $r = 0.14$), where the median administration cost for a conventional speech-language therapy session was RM56.18, which was lower than RM56.19 for teletherapy.

Table 3 showed the breakdown of average costs for a single speech-language therapy session. Caregivers primarily spent the highest amount on transportation to attend a conventional speech-language therapy session, which accounted for 36.1% of the total cost for conventional therapy, but 0% for a teletherapy session. For a conventional speech-language therapy session, some caregivers also spent money on meals, which were reportedly not considered a requirement for a teletherapy session. The second highest expenditure for caregivers was the intervention fee, which amounted similarly to both conventional and teletherapy sessions. Expenditure for consumables (such as papers and stationery) was also reported for both conventional and teletherapy sessions by some caregiver participants. A minimal amount was spent on intervention materials and electronic devices (i.e., smartphone, tablet, laptop or desktop computer) for teletherapy, which were not required in a conventional session. All the caregivers reported using existing devices and did not make specific purchases for teletherapy.

SC participants reported spending money on transportation and meals for a conventional speech-language therapy session, which was considered unrequired for a teletherapy session. In contrast, SCs reported higher expenses for consumables in a conventional session as compared to teletherapy sessions, which was the highest expenditure for SCs, amounting to 54.1% of their expenditure. SCs also spent money on electronic devices and intervention materials for both conventional and teletherapy sessions, which was reportedly minimal. SCs also used existing devices and intervention materials available at the clinic or purchased for their personal use.

TABLE 3: Cost breakdown of conventional and teletherapy modes

| Breakdown component | Conventional (RM) | | Teletherapy (RM) | |
|---|---|---|---|---|
| | Median | Range | Median | Range |
| Caregivers | | | | |
| Intervention fees | 10.00 | 35.00 | 10.00 | 35.00 |
| Transportation | 15.00 | 127.00 | - | - |
| Meal | 0.00 | 50.00 | - | - |
| Consumables | 2.00 | 8.60 | 0.00 | 22.50 |
| Devices | - | - | 0.21 | 0.27 |
| Intervention materials | - | - | 0.00 | 0.0012 |
| Total | 41.50 | 148.00 | 13.25 | 37.77 |
| Student clinicians | | | | |
| Consumables | 9.30 | 27.60 | 0.00 | 10.00 |
| Transportation | 5.00 | 48.00 | - | - |
| Meal | 3.50 | 12.00 | - | - |
| Devices | 0.05 | 0.19 | 0.10 | 0.35 |
| Intervention materials | 0.0004 | 0.001 | 0.00 | 0.001 |
| Total | 17.18 | 68.79 | 0.10 | 10.00 |
| University | | | | |
| Human resources | 31.11 | 12.78 | 31.11 | 12.78 |
| Overheads | 25.00 | 0.00 | 25.00 | 0.00 |
| Intervention materials | 0.004 | 0.02 | - | - |
| Consumables | 0.05 | 0.00 | - | - |
| Capital | 0.02 | 0.01 | - | - |
| Online platform (Zoom) | - | - | 0.08 | 0.00 |
| Total | 56.18 | 12.79 | 56.19 | 12.77 |

For the clinic administration, the university spent a similar amount on human resources and overhead costs for both conventional speech-language therapy and teletherapy, which amounted to almost 100% of the total cost. The cost related to human resources included the salary of lecturers and clinicians who served as clinical supervisors for the students, while overhead costs covered utilities and the university's clinical facilities. Minimal expenditure was reported for intervention materials and consumables required only for a conventional session. A minimal cost was also reported by the university personnel regarding the subscription to the Zoom license for teletherapy.

## DISCUSSION

Analysis of costs and outcomes revealed that the total intervention costs for conventional speech-language therapy were higher than teletherapy in a student-led clinic attached to a public university in the government sector. From the perspectives of caregivers and SC, conventional therapy was more costly than teletherapy. In the present study, the main cost drivers for SC were transportation and consumables. This was because some SCs lived in rented houses or in their own homes with their families, resulting in higher out-of-pocket expenses for transportation to the clinic. However, the transportation costs could be reduced if SC decided to stay in the hostel because the clinic is within walking distance. In addition, they spent money on consumables such as laminated or printed picture cards, face masks and stationeries for conventional therapy. On the other hand, the main cost driver for caregivers was transportation. The majority of caregivers in our study population stated that they still preferred conventional therapy despite the fact that conventional therapy was more expensive than teletherapy. SC had no specific preferences for the mode of service delivery as it depended on the university's directives.

Most of the caregivers claimed that conventional therapy produced better outcomes and was more effective for their children than teletherapy. According to a prior report by Ahmad Rusli et al. (2021), many parents and caregivers continued to seek conventional therapy because their children responded better to the clinician and would benefit more from it. The study further reported that teletherapy is not a one-size-fits-all solution and that the characteristics of the environment and client selection would affect the outcomes of teletherapy. The greatest challenges for telepractice were a lack of cooperation from children during sessions and network issues (Aggarwal et al. 2021).

Our study is also in line with previous studies, which found economic differences between the intervention costs for conventional therapy and teletherapy, with teletherapy offering a cost-effective solution and less expensive because it could reduce travel expenses (Eslami Jahromi et al. 2021; Fairweather et al. 2016; Völter et al. 2021). In addition, Chaudhary et al. (2021) also reported similar results that showed teletherapy was a more cost-effective method of providing services for patients with speech and language disorders. Teletherapy has also emerged as an alternative method of service delivery for patients who live remotely and have limited access to services.

Regarding the clinic administration, despite significant differences in the costs for conventional speech-language therapy versus teletherapy, the effect size discovered was far smaller than the costs borne by the caregivers and students. This was because the manpower needed to run the clinic and the human resources costs were the same for both methods of service delivery. Furthermore, the costs of the intervention materials and consumables needed for conventional therapy were almost comparable to the costs of online software (Zoom) for teletherapy. Caughlin et al. (2020) conducted a study to evaluate the application of telerehabilitation in the stroke population in Canada. According to their findings, the efficacy and cost of teletherapy appeared to be similar to that of traditional conventional management. The clinic administrators who serve as the primary service providers of the intervention program

are flexible and prepared for both modes of service delivery. The key component influencing the clinic administrators to select one service delivery method over another was the needs of the client (e.g., distance from the client's home to the clinic or center, the client's participation in therapy sessions, suitability of infrastructure and stability of internet connectivity).

There are a few limitations associated with this study. Our data were exclusively based on caregiver and SC participants' recall, which may introduce bias in cost estimation. Reliance on participant recall for all expenses (especially intervention materials, devices, transportation and meals) may compromise the precision of the micro-costing calculations. The study was also conducted at a student-led clinic attached to a public university in the government sector. Hence, the total intervention cost could be underestimated. According to the Malaysia Ministry of Health Malaysia (MOH), public healthcare services have always been heavily subsidised by the government (MOH 2021). In 2019, the total public sector health expenditure remained higher than private sector, with an expenditure of RM33.7 billion or 52% of the total health expenditure (MOH 2021). Public primary care services in Malaysia are provided almost free of charge and patients can receive medical care and medication at a minimal cost of RM1 per visit. A total of RM5.7 billion was allocated to the MOH for funding public health services in 2020. The fees collected by the MOH only constitute about 2% of the MOH budget, which means that the government subsidises about 98% of the public health services (MOH 2021).

Additionally, the present study primarily involved participants from middle-income families who lived in the Klang Valley areas. Therefore, the generalisation of the findings to individuals with other income backgrounds and other parts of Malaysia is quite limited. Caregivers from the B40 family might be receiving financial aid that may be usable for accessing services they need. During the COVID-19 outbreak period, many initiatives were made to enhance accessibility and connectivity through the internet, which may support teletherapy practices. However, a lack of sustenance of such support may discourage individuals, especially those with low income.

Finally, most participants preferred and perceived that the conventional mode of therapy, which included face-to-face interaction, is more effective than teletherapy. However, the present study did not explore the effectiveness of conventional therapy versus teletherapy in relation to the cost of speech-language therapy modes. While personal preference and perceptions may bias individuals' involvement in one intervention mode over the other, further studies are needed to compare the effectiveness of conventional speech-language therapy with teletherapy. It is important to note that people living in rural areas often have limited access to speech-language therapy, which tends to further exacerbate the cost of conventional intervention; thus, teletherapy may be a cost-effective option to increase access to speech-language therapy services, especially in low-resourced areas.

## CONCLUSION

The findings of the present study showed that conventional therapy was more costly than teletherapy. By applying the ABC method, we obtained a detailed estimate of costs for a specific service. This may assist policymakers in making decisions about resource allocation, which can help to minimise costs from a societal perspective and improve service delivery. Overall, the results indicate that teletherapy could be a relatively cheaper mode of service delivery for running a student-led speech-language therapy clinic. Future studies are warranted to investigate the relationship between the cost-effectiveness of teletherapy and intervention outcomes.

**Data availability statement:** Supplementary material can be found via this link: https://osf.io/preprints/socarxiv/gwstf_v1

**Author contributions:** Original ideas: FHH, SJS, ASA; NI; Conception of methods: FHH, SJS, ASA,

SMH; NI; Material development: ASA, HMA, NI; Data collectrion: NZJ, SMH, HMA; Data analysis: FHH, NZJ, ASA; Writing-original draft: FHH, NZJ: Writing-review and editing: FHH, SJS. All authors read and approved the final manuscript

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**Ethical Statement:** This study was approved by the Research Ethics Committee of the UKM (Approval Number: JEP-2020-109; Date: March 12, 2020). Data collection was conducted between 23 December 2021 and 10 April 2022. Written informed consent was obtained from all participants prior to their inclusion in the study.

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