

Analysing the Impact of Support Plans on Telehealth Services Users with Complex Needs

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Abstract. The COVID-19 pandemic had a negative impact on people's mental health. This study analysed 430,969 contacts made to more than 100 telehealth services by 1,064 callers with more complex needs who had tailored support plans in place between 31 December 2017 and 3 March 2022. This study aimed to investigate the characteristics of these callers with complex needs, identify caller types, and explore whether the support plans effectively reduced the caller's calling demands. This study used a mixed method. A descriptive analysis was used to explore callers' socio-demographics and calling demand patterns. A K-prototype clustering algorithm was conducted to group callers into four clusters (The Former Users, The Loyal Users, The High Frequency Users and The One-Off Users). Furthermore, a randomisation test was used to compare changes in callers' calling behaviours in different periods. This study presented insights into calling demand patterns and identified calling behaviours for those callers seeking support via helplines. The result showed that callers' average daily contact frequency was significantly reduced due to the effect of the support plans. However, the support plan also had a small influence on reducing the calling frequency for callers from The Loyal Users cluster and The High Frequency Users cluster which suggests that callers from these clusters may need additional support.

Keywords: Pandemic, Mental Health, Telehealth Services, Clustering, Caller Behaviour.

1 Introduction

The COVID-19 pandemic outbreak across the world has also impacted mental health globally. People's usual activities, routines or livelihoods are affected by preventive measures for COVID-19, such as self-isolation and quarantine. Thus, levels of loneliness, depression, harmful alcohol and drug use, and self-harm or suicidal behaviour are expected to increase [32]. In addition to these mental health observations, the World Health Organization (WHO) also has concerns about the disruption of health services worldwide due to the pandemic. Therefore, telehealth is believed to play a critical role in today's scenario. Telehealth allows people to receive psychological and mental health services through phone calls, video, email, or other telecommunications technologies. Telehealth is effective, feasible and acceptable in delivering mental health care [25].

People seeking social or emotional support can easily access various helplines at home. Understanding callers' calling behaviour and demands have been the subject of many studies. It is valuable for operational purposes and may help mental health services understand how crisis helplines can be used to support population-level well-being [30].

In March 2020, New Zealand took several strong control measures to prevent pandemic outbreaks, including an Alert Level 4 lockdown from 25 March 2020 to 27 April 2020. Due to the high restrictions, there were increases in self-reported mental health problems in the community. According to the COVID-19 psychosocial and mental well-being recovery plan published by the Ministry of Health [17], the expansion of mental health services was supported in the community, which included increased capacity for mental health and addiction telehealth services, and funding and promotion of several support telehealth lines. A call log dataset was gathered from various telehealth services made by 1,064 callers with complex needs between 31 December 2017 and 3 March 2022. While only 1,064 people make up this group of callers with complex needs, they have made more than 400,000 calls across the four-year study period. They are people who might need tailored support. Callers in the broad group may be identified as having more complex needs, which may include some of the following indicators:

- Callers underlying needs may not be met via traditional telehealth approach or brief intervention models, and they often contact telehealth services more frequently and persistently.
- These callers may be socially isolated and negatively impacted by poor health, mental health challenges, and other psychosocial difficulties.
- Callers who do have more complex needs may benefit from more holistic support and tailored support plans.

When a caller is identified as requiring additional tailored support, the telehealth team will assess the callers' needs and then develop a plan that helps frontline call staff provide targeted support to improve the outcomes for the service user. A plan usually captures the agreed process for providing the best possible support to a caller with more complex needs. This plan supports the service user and may also minimise the impact of potential high-frequency calling on the service. It consists of simple instructions and directive information developed in consultation with the caller and their medical and mental health provider. This study aims to provide a better understanding of callers with complex needs and inform appropriate support for these callers. The two purposes of this study include 1. exploring the patterns, behaviours and characteristics of complex callers and grouping them into several clusters - where callers in the same cluster have similar characteristics but differ from callers from other clusters based on their demographic information and calling patterns. And 2. identify callers' call patterns before and after their plans due to the intervention of the service plans.

2 Related Work

The socio-demographics among helpline callers have been studied for many years. Spittal et al. [27] applied multivariate logistic regression to identify the characteristics of

frequent callers from an anonymous dataset on calls made between December 2011 and May 2013 from Lifeline (the largest crisis helpline in Australia). The descriptive analysis found that frequent callers account for 3% of all callers but make 60% of calls based on their study of over 411,000 calls. They also found that males and transgender people have a slightly greater risk of being frequent callers than females. This study also suggested that people who have identified mental health problems have more chance of becoming frequent callers. Several studies found that people who frequently call helplines may have complex social, physical, and mental health needs and have a heavy and unhelpful reliance on telehealth services [23]. These studies also showed that frequent callers have mental health problems such as depression, anxiety, and suicidality or have physical illnesses [23,27]. They may also use other healthcare services such as GPs, psychologists, psychiatrists, and emergency departments. However, some researchers believe that other areas of healthcare services are not meeting frequent callers' needs, so they keep calling helplines and looking for social support.

In New Zealand, the proportion of females who experienced psychological distress is 1.4 times higher than males [16]. This rate is almost double in the New Zealand youth group [14]. One study that focused on three youth telephone helplines in the UK also found a similar pattern with two-thirds of helpline callers being female. A scoping review of gender differences in the usage of crisis helplines also found that in most studies, women represented 51% - 66% of calls and frequent callers are more likely to be female [11]. Another review of gender differences in gambling helplines found that in some earlier studies, males represented the highest proportion of gambling helpline callers. However, females contact with the gambling helpline was noted to increase in more recent research [26]. Alternatively, another two helpline studies in Bangladesh reported that most callers are male. This can be explained because males in Bangladesh have more resources to access the services, and females have to focus on the family issue [6,7]. In addition to the male/female gender, very few studies discussed transgender or gender-diverse callers. Transgender and gender-diverse people have been found to have higher rates of mental health problems compared to cisgender people [28,29]. A recent New Zealand COVID-19 related study found that contact demand for gender-diverse populations had a high increase of 51.3% in January and March 2020 [21]. The demands for gender-diverse populations seeking mental health help should also be taken seriously. Based on these studies, gender differences among helpline callers might vary due to social and cultural factors, and gender inequality in access to telehealth services exists in many studies.

O'Neil et al. [20] looked for patterns and behaviours of all callers who contacted Samaritans Ireland seeking mental health support between April 2013 and December 2016. A total of 3.449 million calls in the four years were analysed. Their study used K-means clustering to identify callers based on their calling patterns (number of calls, mean call duration and standard deviation of call duration). Callers in the same cluster have similar features in comparison with other clusters. Their study suggested that 5 or 6 clusters are reasonable based on their data. Each cluster was interpreted, and they explained callers' behaviours in each cluster. For example, there is one cluster called 'typical caller'. About 40% - 50% of callers were grouped into this cluster. They usually called five or six times with a short 3 to 4 minutes conversation. Another cluster called

'one-off chatty callers' grouped people who only call one to two times with a long 30- to 1-hour conversation and do not contact again. Based on this study and their clustering solution, Turkington et al. [30] explored how callers' patterns change in each cluster before and during COVID-19 on a week-by-week basis. They found that callers' behaviour changed as a result of COVID-19. Callers made more calls with longer conversation times during the COVID-19 period than before COVID-19.

3 Methodology

This study applied a mixed method to achieve project objectives. The descriptive analysis helped identify the socio-demographics of callers with complex needs and understand how the patterns of contact demands change regarding callers' gender, ethnicity, and age group. The K-Prototype clustering method was applied to identify callers' types based on their demographic information and contact patterns. A non-parametric randomization test was conducted at last to explore how callers' contact patterns change under the intervention of support plans and determine what types of callers may need additional support.

3.1 Dataset

A call log dataset made by 1064 callers with complex needs between 31 December 2017 and 3 March 2022 from various New Zealand telehealth services was recorded. A total of 430,969 contacts were analysed. The call dataset includes a date-time stamp of each contact, interaction type, whether made via phone calls or SMS, duration of each call, user ID and users' demographic information, and what telehealth services this contact made to. There were over 100 telehealth services involved in the call log dataset. They were categorised into seven types named Mental Health Services, Mental Health Crisis Line, Family & Sexual Harm Services, Health Services incl COVID, Smoking Cession Helpline, Poisons and Care Coordination. Due to the sizeable missing value appearing in the call duration and ensuring the data authenticity, we did not use any methods to impute the missing value for call duration. Further analysis of call duration will be only based on the 254,877 call duration recorded.

Another user dataset was extracted from the call log dataset. The user dataset contains demographic information of 1064 callers and their relative contact behaviours. These features include callers' ID, users' gender (female, male, gender diverse and unknown), ethnicity (NZ European, Maori, Asian, Pacific Peoples, MELAA and unknown), and age was grouped into seven categories which are 17 and under, 18-29, 30-39, 40-49, 50-59, 60 and above and unknown. We also defined several periods during the study period. Callers' active period is the period between their first contact and last contact throughout our study period. The callers' non-active period is between the users' last contact and 3 March 2022. Callers' cumulative number of calls and daily contact frequency was calculated, respectively (i.e. a user made a total of 1215 contacts during the active period of 1521 days, then this user's daily contact frequency is 0.8 contacts per day).

3.2 Clustering Analysis

Clustering is a data mining technique used to group a set of data objects into different clusters where data objects in the same cluster are more similar but differ from the data objects in other clusters [8]. Some traditional clustering algorithms can mainly deal with numerical-only datasets such as the K-means algorithm or categorical-only datasets such as K-mode algorithms. These result in a limitation when clustering a mixed-type dataset. The problem with clustering a mixed dataset is that dissimilarity definitions vary between numerical and categorical variables. Although we can use the label encoding technique to convert categorical variables into numerical variables, it would lose the original meaning of the dataset [12]. We applied the K-prototype algorithm, which combined K-means and K-mode to deal with the mixed-type dataset. The dissimilarity between the numerical variables is calculated by Euclidean distance and simple matching distance for categorical variables.

All numerical variables were standardized at a mean is 0, and a standard deviation is 1 before we ran the clustering algorithm. To determine which attributes are suitable for clustering, we measured the feature importance by fitting a K-prototype using all features in the user dataset. The misclassification rate for each variable was calculated to determine whether this variable has a huge influence on the clustering result or not. We finally selected users' active period, non-active period, the cumulative number of calls and age group for clustering. Users' active and non-active periods represent their stickiness in using the services. The number of contacts indicates their call volume, and the age group can help to understand that users in the same age group might share similar contact behaviours.

The number of clusters is the parameter we need to decide on at the beginning when we use the K-Prototype clustering method. We chose the number of clusters $K=4$ suggested by the elbow method in **Fig. 1** showed.

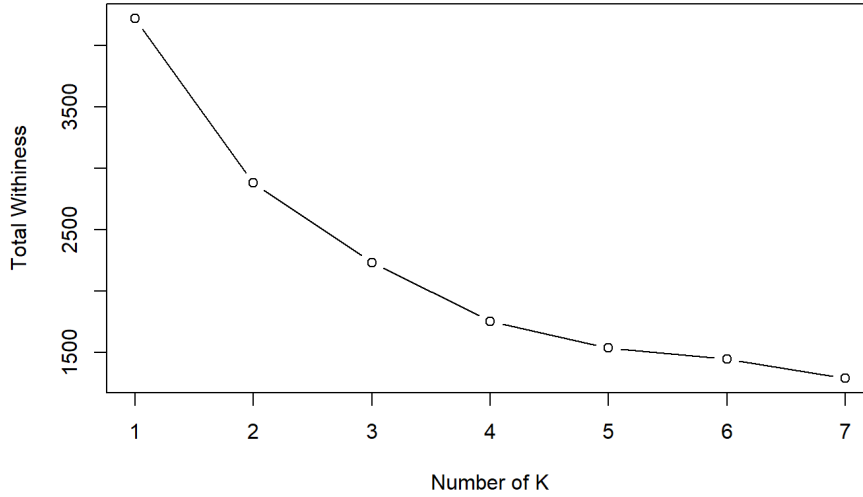


Fig. 2. Elbow Method

3.3 Period Define

Every caller with complex needs is supported with tailored support plans to achieve the best outcomes, and each caller has a different plan start/end date. The period before a caller's support plan start date is referred to as the pre-plan period, and the period after a caller's plan end date is referred to as the post-plan period. For those callers who no longer have active support plans in place, we extracted 308 callers who had a plan in place for more than two days and identified the number of contacts they made before and after their plan ended, converted into daily contact frequency. Callers' average call duration in the pre-plan period and post-plan period were also computed, but only 19 callers had average call duration recorded in both periods.

4 Result

4.1 Sample Characteristics

A total of 430,969 contacts made by 1,064 callers between 31 December 2017 and 3 March 2022 from all helpline services were analysed. In general, the daily contact volume was found to be stable in the year 2018, with an average of 200 contacts per day, followed by a rapid increase in the year 2019. The contact demands peaked in 2020 with a high increase of 50% compared with 2019. In 2021, the contact volume declined by a 3% decrease.

By looking at the contact volume trend in several service types, contacts made to Mental Health Services are consistent with the overall trend, which has an increase of

53% in 2020 and a decrease of 19% in 2021. It was astonishing to see the contact volume made to Family & Sexual Harm Services in 2020 had an increase of 240% and another increase of 22% in 2021. The Mental Health Crisis Line also showed a continuous upward trend with a 41% increase in 2020 and a 10% increase in 2021. In contrast, the Health Service incl COVID showed a continuous downward trend with a 14% decrease in 2020 and a 9% decrease in 2021. A slight increase was observed for contacts made to Smoking Cession Helpline, with a 5% increase in 2020 and a 7% increase in 2021. The contact demand peaked at night during our study period. 27.4% of contacts were made between 6 pm and 10 pm.

Gender

More than half of users are female (56.6%), followed by male (38.4%), less than one per cent (0.8%) gender diverse callers, and 4.2% of callers did not specify their gender. The number of female callers is more than the number of male users, which holds true for each known age group. Especially in the age group 18-29, the female callers are twice as male callers, and the gender ratio increase to three times in the age group 17 and under. The gender-diverse people were observed in the age group 17 and under, 18 - 29 and 30 - 39. There is a 32% increase in female callers in 2020, followed by a slight decrease in 2021 (-0.1%). A high increase of 46% was observed from male callers in 2020 and a slight increase of 5% in 2021. For gender-diverse callers, a 13% increase in contact demand was observed in 2020, and this volume became 2.7 times higher in 2021.

Ethnicity

The majority of users are NZ European (66.4%), 12.5% of users are Māori, 2.4% are Asian, 1.4% users are Pacific Peoples, 0.4% of users come from MELAA, and 17% of users did not specify their ethnicity. Further explored contact volume trend made by ethnicity, there is a 28% increase from European callers in 2020 and a minimal 1% increase in 2021. An increase of 19% from Māori callers in 2020, followed by a 21% decrease in 2021. Similar patterns were observed for Pacific Peoples and Asians. A 50% and 98% increase from Pacific Peoples and Asians in 2020, followed by a 21% and 12% decrease in 2021, respectively.

Age

In terms of age, teenage users aged 17 and under account for 4.4%. An increase of 32% and 134% in contact volume was made from this age group in 2020 and 2021, respectively. Young adults in the age group 18-29 account for 19.3%. An increasing trend of 108% and a decreasing trend of 1% were observed in this age group in 2020 and 2021, respectively. Users aged from 30 to 39 account for 15.5%. An increase of 28% and a decrease of 18% were made from this group in 2020 and 2021. Mid-aged users in the age group 40 - 49 account for 19.1%. In 2020 and 2021, their contact volume increased by 35% and 16%, respectively. Callers aged in the 50-59 group account for 17.8%. Their contact volume trend showed similar patterns with calls in the age group 40-49. Users aged 60 and above account for 18.6%. The contact volume

increased by 42% in 2020 and slightly decreased by 0.9% in 2021. There are remaining 5.4% of users are of unknown age.

Interaction Type

The phone call is the major channel for callers to access the services, followed by SMS and other interaction types (i.e., email and webchat). However, there is a very high increase of 85% in contact volume made via SMS in 2020 followed by another 9% increase in 2021. Contacts made via phone call have a 46% increase in 2020 and a 4% decrease in 2021. For other interaction types, including email and webchat, a high 120% increase was observed in 2020, followed by a 14% decrease in 2021.

In addition, younger callers are more likely to use SMS than older callers—the proportion of using SMS decrease with the age group increase. There are 57% of contacts made via SMS and 43% of contacts made via phone in the age group 17 and under, 45% of contacts made via SMS in the age group 18-29, 16% of contact volume was made by SMS in the age group 30-39, 7% contacts volume made by SMS in age group 40-49, 4% contact volume made by SMS in the age group 50-59 and the proportion of using SMS in the age group 60 and above further decrease to 2%.

4.2 Clustering Results

We generated a four-cluster solution (see **Table 1**) based on callers' active period, non-active period, calling volume and age group. We then interpreted this clustering result based on callers' demographic and calling patterns (see **Fig. 3**) in each cluster as follows:

Table 2. Clustering Results. It shows the cluster size, the percentage accounts and the within sum of squares of each cluster.

Cluster	Size	Proportions	WSS
1(The Former Users)	334	31.4%	515.5
2(The Loyal Users)	536	50.4%	716.3
3(The High Frequency Users)	33	3.1%	259
4(The One-Off Users)	161	15.1%	263.2

1. Cluster One (The Former Users)

It contains the most significant number of female users aged 18-29. Their average active period is one and a half years, and the non-active period is 217 days. They did not have a high call volume, with an average of 97 contacts during their active period, typically making 0.29 contacts per day. Each call can last for 16 minutes on average.

2. Cluster Two (The Loyal Users)

A giant cluster. Most users are mid-aged to elder-aged females. They have a long active period and a short non-active period. This cluster has been using the services for

3.7 years and made 392 contacts on average. Each call can last for 14 minutes on average.

3. Cluster Three (The High Frequency Users)

This cluster has only 33 users, but they contributed 40% contact volume. They have incredibly high contact demands, make more than 5000 contacts and can make four contacts per day, and each call can last for 11 minutes during their active period on average. Their active period and daily contact frequency are the highest, while their non-active period and average call duration are the shortest among all clusters.

4. Cluster Four (The One-Off Users)

The minor active users with the slightest contact demands only made less than one hundred contacts on average. They have not returned to the services for more than two years. However, their contact duration is the longest, with an average of 17 minutes.

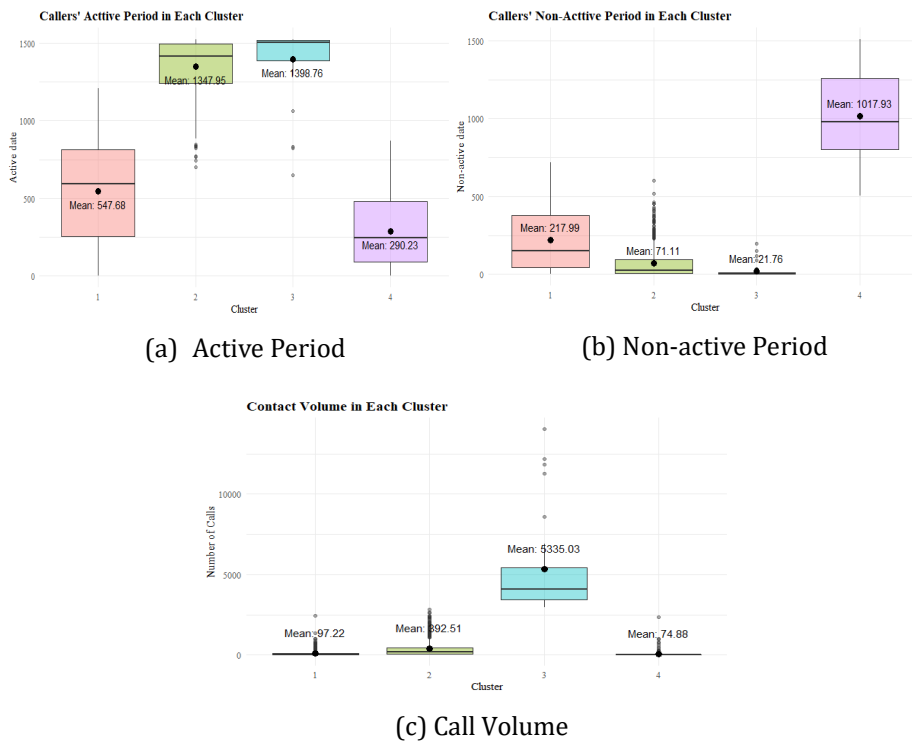


Fig. 4. Calling Patterns by Clusters

4.3 Calling Patterns Change

The mean and median of the daily contact frequency were reduced in the callers' post-plan period. Callers' were found to have a mean of 0.82 contacts per day (or 24.6 contacts per month) and a median of 0.34 contacts per day (or 10.2 contacts per month) in their pre-plan period. And a mean of 0.68 contacts per day (or 20.4 contacts per month) and a median of 0.19 contacts per day (or 5.7 contacts per month) in their post-plan period. To determine whether callers' daily contact frequency significantly reduced after their plan ended, a paired randomisation test was performed, and a significant decrease in daily contact frequency in callers' post-plan period ($p < 0.05$).

Callers' daily contact frequency was concentrated at a lower value after their plan ended for all clusters. To determine whether the effectiveness of service plans on reducing callers' daily contact frequency is differ by cluster between periods, a randomisation test was performed, and a significant decrease in daily contact frequency in the post-plan period was observed in clusters 1 and cluster 4 ($p < 0.05$). Although there was a visible difference in daily contact frequency between periods in cluster 2 and cluster 3, no evidence showed their decreases were significant ($p > 0.05$).

5 Discussion

Our study analysed 430,969 contacts made to more than 100 national telehealth services by 1,064 callers with complex needs over four years. Callers were more likely to seek help at night, around 9 pm and 12 am. Many studies reported that calls to helplines peaked at night or during the weekend [6,20]. People may have more free time to contact helplines in the evening or at weekends without interruption. Also, loneliness or sleep disturbance may occur more frequently at night [2] and this might explain why a peak appeared around midnight. Contact demands for telehealth services experienced a high increase of 50% in 2020 due to the COVID-19 pandemic effect, followed by a declining trend. It should also be noted that contact volume started to rapidly increase in 2019 (especially those contacts made to mental health services) before cases of COVID-19 were confirmed in New Zealand, and the government announced several control measures.

In 2020, increased contact demands were observed for Mental Health Services, Mental Health Crisis Line, Family & Sexual Harm Services and Smoking Cession Helpline, and a very high increase of 240% for Family & Sexual Harm Services. This can be explained by the increasing rate of psychological distress and increased risk of family violence during COVID-19. Isolation can exacerbate pre-existing mental health problems [24] and cause economic stress accompanying potential increases in harmful coping mechanisms such as alcohol abuse [31]. Unemployment, reduced income, limited social support, and alcohol abuse are the common risk factors that trigger family violence [4]. Many studies reported the increasing rate of family violence after the lockdown measures. Children and pets are also victims of family violence, at a greater risk of suffering physical and emotional harm [3]. In addition, the increasing contact demands in 2020 and 2021 for Smoking Cession Helpline is consistent with another youth Smoking Cession Helpline study from Hong Kong that the number of incoming calls

and the quit rate of using tobacco increased since the COVID-19 outbreak [5]. One reason for observing this increase is that most smokers are concerned that smoking increases the risk of getting infected with COVID-19 [10]. The health risk related to COVID-19 is the main factor for smokers to have quit intentions [33]. As we observed from the contact volume trend, a general downward trend appeared in 2021 when there were no lockdown restrictions. However, it came with increasing demands for the Mental Health Crisis Line, Family & Sexual Harm Services and Smoking Cession Helpline. The impact on mental health and family issues caused by the pandemic might last longer.

Another trend that needs to be discussed is the increasing number of contacts made by SMS. An increase of 85% and 9% in SMS contacts were found in 2020 and 2021, respectively, while the number of phone calls decreased in 2021. We also found that younger callers are more likely to use SMS. An Australia COVID-19 related youth helpline study found similar patterns in which the increased contact was entirely in the wechat because young people have more concerns about privacy. They worried that their family members might overhear their personal information if they used the phone call to contact helplines [1]. This suggests that all youth helplines could consider text-based communication.

Our sample was predominantly by females. Call volume from males, females and gender-diverse people all showed an increasing trend during the pandemic, and the percentage of increase from male callers was higher than from female callers. As we mentioned before, the proportion of female callers is higher than male callers in many previous studies. Several studies reported that females have higher depression and anxiety scores based on some self-report scales during the pandemic [19,22] which means females are more likely to experience poorer mental health under the impact of COVID-19. Another reason might explain the shortfall in male callers observed in the majority of helpline studies. An earlier sociological study found that 'traditional masculine scripts' prevents men from seeking help [13], especially in the case of psychological problems [9]. Due to traditional gender roles, males are discouraged from showing their emotions and are less likely to seek support. In New Zealand, males died by suicide at 3.3 times higher than females [15]. There is a need for mental health services to target males who might need support and provide early intervention. In addition, the help-seeking patterns may vary between gender, with females more likely to perceive emotional support while males are more likely to perceive instrumental support [18]. This suggests that when we develop support plans for complex callers, their social-demographic has to be considered.

Using the K-Prototype clustering method, our study identified four complex caller types based on their age group and contact patterns. Compared with a study from O'Neill et al. [20], similar contact patterns were found in a group of callers with the highest contact demands and a group with the lowest contact demands. We also analysed the difference in daily contact frequency and average call duration between callers' pre-plan and post-plan periods. Our study found that callers' daily contact frequency significantly reduced after their support plan session ended, representing the decrease in callers' contact demands resulting from the intervention of support plans. However, we did not find any decrease in callers' average call duration in the post-plan period.

Our study further explored the difference in daily contact frequency on a cluster basis. The result showed that the support plan efficiently decreased daily contact frequency among clusters 1 (The Former Users) and 4 (The One-Off Users) callers. However, no significant decrease was observed for cluster 2 (The Loyal Users) and cluster 3 (The High Frequency Users) callers, where these callers usually have moderate to high call volume and high reliance on telehealth services. This result suggested that callers from clusters 2 (The Loyal Users) and 3 (The High Frequency Users) may need more health support.

6 Conclusion

This study explored the contact volume trend made to telehealth services under the impact of COVID-19 and summarised the socio-demographics of 1,064 callers with complex needs supported by tailored support plans. Four clusters were identified based on their age group and contact patterns. Helpful information for each cluster was delivered. Contact demands from cluster 1 (The Former Users) and cluster 4 (The One-Off Users) callers were reduced due to the effectiveness of the support plan—however, small influence on reducing contact demand from cluster 2 (The Loyal Users) and cluster 3 (The High Frequency Users) callers. This result also suggested callers in cluster 2 (The Loyal Users) and cluster 3 (The High Frequency Users) may need greater support. This study explored some reasons that may cause the patterns of demands among different types of callers and suggested that callers' demographic information be considered when developing support plans. For example, younger callers have more concerns about privacy and are less likely to open up, and text-based communication may help build a trusting relationship with younger callers.

Limitations also exist in this study. The result towards callers' average call duration may not be accurate due to the large missing value appearing in call duration. Compared with another clustering study [20], average call duration was an important variable in identifying types of callers. Exploration of callers' satisfaction with the support they have received at the end of the session and evaluating the support plans from the perspective of callers is recommended in future work.

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