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Increasing social participation through morning SNS roll-call and personalized conversations: Targeting individuals who live alone with customized messaging

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Abstract

This study examines the effectiveness of Online-Kayoinoba, an online community-based initiative launched in Oita Prefecture during the COVID-19 pandemic (2021 to present). The initiative aims to promote social participation, support independent living, and extend the healthy life expectancy of older people, including those living alone. It utilizes the Nou-Waka 365 chat communication system (Somelight Ltd.) on LINE SNS to connect seniors with their local communities and facilitate activities that prevent nursing care needs. Daily mass messages in the morning with personalized responses are transmitted to participants, who can reply voluntarily. The research aims to determine if Nou-Waka 365 can mitigate the risk of communication loss for older people living alone during a pandemic and to develop a method for creating personalized messages based on detailed changes in their responses. Methods involved analyzing reply data from 79 consenting participants using word co-occurrence analysis (KH-coder) and sentiment analysis (AI analysis based on JIWC dictionary, then manual correction). Key findings reveal that older people living alone exhibited a significantly higher reply rate than those who did not. Co-occurrence analysis highlighted changes in participants' interests and activities. Sentiment analysis indicated a trend of increasing positive emotions following expressions of sadness. In conclusion, Online-Kayoinoba has the potential to contribute to the social participation and mental well-being of older people, underscoring the importance of continuous, personalized communication. Future research should focus on long-term effects and advanced personalization techniques.

Keywords: living-alone older adults, social participation, sentiment analysis, personalized communication, SNS, COVID-19, Nou-Waka 365, Nouwaka, Online-Kayoinoba, personalized messaging

Introduction

Background

The increasing number of older adults living alone presents distinct challenges concerning safety, social engagement, and emotional well-being, making it crucial to explore technological advancements to address these issues. The COVID-19 pandemic has further exacerbated these challenges, notably social isolation and loneliness, underscoring the importance of technology in promoting well-being. Information and Communication Technology (ICT) has gained attention as a means to enhance independence and Quality of Life (QOL) for older people. Studies have increasingly emphasized the need for ICT solutions tailored to their unique needs.

In Oita Prefecture, Japan, which faces a significant aging population, community-based initiatives like "Kayoinoba" (community gathering salons) have been promoted. To adapt to social changes, especially during the COVID-19 pandemic, Online-Kayoinoba was launched. This initiative utilizes the Nou-Waka 365 chat communication system (Somelight Co., Ltd.) on the LINE SNS to connect seniors with their local communities and facilitate activities, thereby reducing the need for nursing care. (SNS: Social Networking Service; LINE is a provider of SNS.) At Nou-Waka 365, participants receive daily morning mass messages. They voluntarily respond to the message and engage in a conversation with Nou-Waka operators, who provide personalized responses.

This study analyzes how older adults communicate and exchange information through Nou-Waka 365, and how this affects their Quality of Life (QOL).

Prior research: Living-alone older people and social participation

The rising number of older adults living alone presents distinct challenges that require innovative solutions to ensure safety, social engagement, and emotional well-being. Issues such as social isolation, loneliness, and concerns about personal security are particularly pronounced among this demographic, making it essential to explore how technological advancements can effectively tackle these problems.

The Gerontechnology journal has highlighted several promising interventions designed to enhance the quality of life for older adults living alone. Ishihara and Ishihara (2023) conducted a pilot study on a talking teddy bear robot to facilitate social conversations. The findings demonstrated that the robot's expressive capabilities fostered creative communication and promoted meaningful social interactions, highlighting the potential of companion robots to alleviate loneliness.

In addition to addressing emotional well-being, personal safety is a significant concern for older adults living alone. Santana and Bianchi (2018) examined the effects of personal alarm systems on perceived safety and security. Their study concluded that such systems significantly improved users' sense of safety, contributing to their overall well-being and independence.

Prof. Yeh-Liang Hsu and his team have conducted pioneering work for reducing social isolation with a net-connected photoframe (Chen et al., 2011) and with interpersonal communication robots for older adults (Chen et al., 2013).

Complementing these findings, Wister et al. (2021) conducted a scoping review of technological interventions aimed at reducing loneliness and social isolation among community-dwelling older adults. Their research emphasized the role of Information and Communication Technology (ICT) solutions in fostering social connections and enhancing quality of life, highlighting the versatility and scalability of these interventions in supporting older adults.

These studies collectively illustrate the potential of technology to address the diverse needs of older adults living alone. Nevertheless, further investigation is necessary into the long-term efficacy, accessibility, and cultural adaptability of these interventions.

Prior research: Addressing the impact of COVID-19 and other social challenges on older adults

The COVID-19 pandemic has amplified existing challenges faced by older adults, particularly in areas such as social isolation, loneliness, and maintaining physical and mental well-being. Prolonged social distancing and disruptions to community support systems have made technology crucial for addressing these issues. From wearable devices to interactive technologies, numerous innovations have shown promise in enhancing the quality of life for older adults during the pandemic and beyond.

A notable study by Gu, Hamido, and Itoh (2024) examines the impact of wearable activity trackers on the physical activity levels and behavior changes of older adults before and during the COVID-19 pandemic. This research highlights the potential of wearable technologies to promote greater awareness and motivation for maintaining physical health, even in the face of external disruptions.

The exploratory study of Google Nest Hub devices in long-term care facilities in Manitoba, Canada (Murphy et al., 2022), provides further evidence of the potential for interactive technologies to combat social isolation. During the pandemic, these devices enabled residents to maintain virtual connections with loved ones, demonstrating the applicability of consumer technology in long-term care settings.

Together, these studies reveal a broad spectrum of technological solutions that can address critical issues faced by older adults, particularly during periods of heightened social and physical constraints. However, gaps remain in understanding the long-term implications and scalability of these interventions.

This paper aims to build on these findings by exploring how technology can be effectively leveraged to support the well-being of older adults in the context of future societal challenges. By synthesizing existing research, this study aims to inform the development of practical strategies and policies for integrating technology into the daily lives of older adults.

Prior research: ICT for social participation of older adults

The integration of Information and Communication Technology (ICT) into the lives of older adults has gained significant attention as a means to enhance independence and improve quality of life (QoL). With global demographic shifts resulting in aging populations, adopting ICT tools to support independent living, social engagement, and personal development has become a pressing concern. Studies have increasingly highlighted the importance of designing ICT solutions tailored to older adults' unique needs and preferences.

Several notable works provide a foundation for understanding the challenges and opportunities associated with ICT adoption among this demographic. For instance, Ishihara and Ishihara (2022) performed a multivariate analysis of a government-led large-scale international survey comparing ICT device usage among older adults in Japan, Germany, Sweden, and the United States. Their findings underscore the significant disparities between nations and emphasize the role of cultural, economic, and technological contexts in shaping ICT engagement.

Chen and Schulz (2016) have conducted a meta-analysis of 25 studies on technological interventions to reduce loneliness and social isolation, identifying these factors as critical determinants of successful independent living among older adults. They found that applying ICT alleviates older people's social isolation through four mechanisms: connecting to the outside world, gaining social support, engaging in activities of interest, and boosting self-confidence. They also found that the positive effect of ICT use on social connectedness and social support seemed to be short-term and did not last more than six months after the intervention. Aiming for the long-term effect of encouraging social behavior is one of the significant challenges.

Bernhold and Giles (2019) examine how older adults internalize memorable messages about aging and how these messages influence their perceptions of aging successfully. They emphasize the role of positive and efficacious messages in promoting a successful aging experience.

Prior research in Gerontechnology has explored various technological interventions to support older adults living alone. These include companion robots to mitigate loneliness, personal alarm systems to improve perceived safety, and ICT solutions to foster social connections. However, further investigation into the long-term efficacy and accessibility of these interventions is needed.

Nou-waka 365

Somelight Co. and the NPO (Care Prevention and Energizing Older Adults Committee) jointly launched the "Nou-Waka 365 (Brain-Young)" morning roll-call service via LINE in May 2018. This service has since been adopted by over 20 cities, towns, and prefectures.

Participants receive daily broadcast messages at 7 a.m., which include guidance on health, nutrition, physical activities, and seasonal greetings. Although responding to these messages is optional, a significant number of participants choose to do so. Somelight staff provide individualized responses to each participant, informed by their conversational history and expressed interests.
The following guidelines govern staff responses:
When formulating a reply, reiterate the other person's statements to confirm comprehension (e.g., "So it is ○○, right?").

Avoid negative or critical language, and instead employ considerate phrasing.

For specialized inquiries (e.g., medical matters), provide generally accepted advice (e.g., "It seems ~ is recommended. If you are concerned, please consult a local medical institution."). Humorous remarks are permissible within reasonable limits, provided they are not deemed offensive.

Do not compel participants to take specific actions.

If staff encounter uncertainty regarding a question or situation, they will assist with customer service.

In Oita prefecture, the service commenced in July 2021. After more than three years, the roll-call and reply activities remain active.

Consequently, we have observed the efficacy of behavioral changes in fostering social participation among older participants.

Aims of this study

This paper aims to build upon existing research by exploring the role of innovative technologies in promoting safety, social engagement, and emotional well-being among older adults living alone.

This study investigates the efficacy of the Online-Kayoinoba and Nou-Waka 365 platforms in Oita Prefecture. Specifically, we focus on its potential to address communication loss among older people living alone, a risk that is exceptionally high during the COVID-19 period. Our work also aims to develop a methodology for detecting detailed changes in participant replies to facilitate personalized encouraging messages. The main aims of this study are twofold:

1. To examine whether the Nou-Waka 365 platform can enhance communication among older people, particularly those living alone, during the COVID-19 pandemic, where the risk of communication loss is exceptionally high.

2. To develop a methodology for detecting detailed changes in each participant's replies and utilize this information to create personalized and encouraging messages. It also requires de-

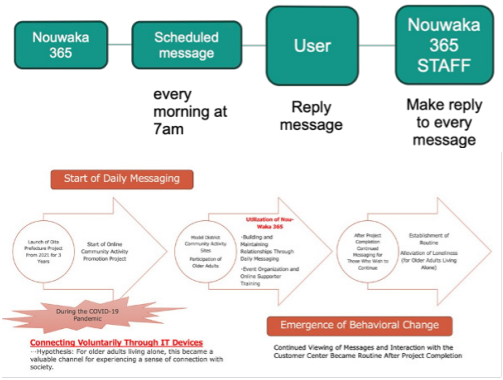

Figure 1. Upper: Daily morning roll call and response making at Nou-Waka 365 platform
Lower: Behavioral Change in Oita Prefecture "Online-Kayoinoba (casual meeting place)" Project: Establishment of conversational activities

veloping methods for tracking these changes over time. While the first topic has existing literature in Gerontechnology and related disciplines, very little work has been done on this topic (e.g., Bernhold & Giles, 2019).

Methodology

This study is an observational study conducted during the COVID-19 pandemic (from 2021 to the present) that aims to clarify the social participation and communication status of older adults in the online community "Online-Kayoinoba" implemented in Oita Prefecture.

Research design

This study employed a mixed-methods research design, integrating quantitative and qualitative analyses to examine changes in communication behavior and emotions of older adults over time in the online community "Online-Kayoinoba".

Participants and research ethics procedure

The participants in this study were older adults who registered for LINE's Nou-Waka 365 program during the Online-Kayoinoba project, conducted by Oita Prefecture.

In 2021, NPO held introductory face-to-face lectures on smartphone and tablet usage, as well as lectures on LINE and Zoom manipulation, a total of 28 times in 7 cities in Oita. Older adults, especially local community leaders, participated and learned. In 2023, more lectures were held, including seven face-to-face and eight online lectures in 8 cities, as well as two spontaneous community lectures and two lectures for online supporters. The most significant number of participants at the lecture was 50. Through these educational and promotional activities, participants of Nou-waka 365 at Online-Kayoinoba were familiarized with their smartphones and the LINE SNS application.
The participants provided written consent for their participation in the research and the use of their data at the beginning of the project. In December 2023, the prefecture office requested a consent form again regarding data analysis. Seventy-nine participants returned signed agreements, including 14 older adults living alone and 65 older adults not living alone. The selection criteria for participants were those who were part of this project, received research information and consent forms by mail, confirmed the contents, and returned the signed consent forms. The data of participants who had not given consent for analysis were excluded from further analyses. This study received ethical approval from the Ethics Committee of Oita Prefecture with the approval number 2-13.

The average age of all participants was 75.8, the median was 76.0, and the Standard Deviation was 5.6. Living alone older adults: average 76.2, median 78, SD 5.1. Not living alone older adults: average 74.9, median 74.0, SD 5.9. Many of the participants were in their 70s and were relatively independent and healthy older adults. The oldest participant was 94 years old.

From a personal information protection standpoint, we did not investigate participants' health conditions. Even if we partially learned about them through replies with staff, we did not record that information. Unfortunately, several participants passed away during the project period.

Most of the older adults over 80 continued to use Online-Kayoinoba after the project ended.

Data collection methods

Text data of participants in Nou-Waka 365, the platform for Online-Kayoinoba, including reply data and the content of voluntary replies, were analyzed. Participants receive daily mass messages in the morning and can reply voluntarily on the Nou-waka 365 platform. These reply text data were analyzed using both quantitative analysis, to examine the reply frequency of different groups, and qualitative analysis, including word-based analysis and sentiment analysis. The details of the analyses are mentioned below.

Analysis methods: quantitative analysis

Comparison of Reply Rates: The reply rates of older adults living alone and those not living alone were calculated and compared. Every morning of the year, morning posts are made. Specifically, reply rates in the four periods

of 2023 were analyzed: Period 1 (January to March) has 90 observations (90 days), Period 2 (April to June) has 92, Period 3 (July to September) has 92, and Period 4 (October to December) has 92.

Statistical tests

The statistical test we perform here aims to determine whether Reply_ratio is affected by Living_Alone / Not and Period, and whether the interaction between Living_Alone / Not and Period also affects Reply_ratio.

First, the distribution of the reply ratio (reply number per participant) was examined with the Shapiro-Wilk test. Deflection from the normal distribution was significant ($W = 0.911$, $p < 0.0001$).

Classic nonparametric methods for ANOVA, such as the Kruskal-Wallis test, Mann-Whitney U test, Friedman test, or Wilcoxon signed-rank test, perform one-way ANOVA, permitting the analysis of only a single factor at a time. However, these methods cannot be applied to multi-way ANOVA (Wobbrock et al., 2011). Conover and Iman (1981) introduced the rank transformation of n-observations, which ranks from the smallest (as the 1st) to the largest (n-th), then applied standard statistical tests such as the t-test, Pearson correlation, and linear regression. Sawilowsky (1990) pointed out that simple rank transformation has a risk of increasing Type I error (false positive) in multi-way ANOVA. Wobbrock et al. (2011) introduced the Aligned Rank Transform (ART) method. This method aligns observations by residuals from the estimated mean value (each_observation - estimated_mean), using a generalized linear model (GLM). In a two-way ANOVA model, residuals from the GLM with the objective variable as observations, and explanatory variables of Factor_A, Factor_B, and interaction_of_A_and_B, are used for alignment. They proved the method does not increase Type I error with a large number of simulation runs.

In this analysis, reply_ratio was aligned with the ART method (ARTool package for R by Elkin et al., 2021). Then, the two-way ANOVA model (Type III) was defined as "Reply_ratio ~ Living Alone/Not + Period + period × living_alone/not_living_alone".

Analysis methods: qualitative analysis

Co-occurrence word analysis

Word co-occurrence-based text analysis examines how words appear near one another within text data, revealing the text's underlying semantic and thematic structures. Researchers can infer meaningful relationships and interpret shared contexts by identifying how often specific terms co-occur within a certain window size or at the sentence or paragraph level. This method is particularly effective in uncovering hidden patterns that may not be visible from simple frequency counts of individual terms. Additionally, word co-occurrence analysis can help identify clusters of closely related words and map conceptual or topical associations within a specific domain. We used the text analysis tool KH-coder (Higuchi, 2016) for co-occurrence-based text analysis.

A co-occurrence word analysis was conducted on the free-text replies of a specific participant (Participant N) using the KH-coder to extract characteristics of interest and daily activities. For participant N, we have analyzed her replies made at each period: January to March, April to June, July to September, and October to December.

Analysis results from two periods, January to March and October to December 2023, were shown. These periods were selected to capture changes observed in Participant N's activities.

Sentiment analysis

Sentiment analysis has become popular in various fields, including marketing analysis and automated recommendations. Although it has broader applications, most are intended for positive/negative discrimination or grading between the two (Beller et al., 2024). Most commercial applications need only positive/negative levels of text. Several cutting-edge research studies have found it challenging to understand more complex sentiments, and there are difficulties since sentiment databases for BERT (Bidirectional Encoder Representations from Transformers) or LLM (Large Language Model) learning are minimal (Islam et al., 2024). Also, sentence databases were built from English texts. Japanese large-scale text databases typically lack sentiment information.

In this research, we have explored a methodology for Japanese sentiment analysis that utilizes AI analysis.

Sentiment analysis was performed on the replies of a specific participant (Participant O), collected from October 2023 to July 2024. This period began after she gave her consent to the research and ended with the analysis for this paper.

The aim is to understand the transitions in emotions, including sadness, anxiety, acceptance, trust, surprise, and joy. The analysis period was selected to track the changes in Participant O's emotions over a longer period.

Since her replies have a larger volume, preprocessing with AI would be helpful. We have used dictionary-based semantic emotion estimation, a conservative and stable approach in AI. The JIWC dictionary (Japanese Linguistic Inquiry and Word Count, Shibata et al., 2017) has 968 words (most are nouns and adverbs) that possess emotional values in seven categories based on Plutchik's (2010) circle of emotions: Sadness, Anxiety, Disgust, Trust, Surprise, and Anger. The words and emotional values originated from over 28,000 queries in Internet evaluation surveys. Our text parsing program, which utilizes morphology analysis and a dictionary lookup program, was based on Kunirou Ito's program and article (https://qiita.com/ItoKuroinu/items/4f10d82fb7395fc57647).

Two authors (Mitsuoka and Ishihara) reviewed the AI-based estimation of emotions. Approximately 40% of the machine estimations were revised, mainly due to excessively estimated values and misunderstandings of mixed emotion expressions. There were limitations of AI-based estimation regarding mixed emotion expressions. "Acceptance" was manually scored by two of the authors in her replies; although a critical emotion, it was not included in the JIWC dictionary.

Results

In this study, we analyzed the communication status and emotional changes of participants in the online community "Online-Kayoinoba" project on the "Nou-waka 365" platform, which aims to improve the social capital of older adults. This section presents both the quantitative analysis results (participants' reply rates) and the qualitative analysis results (co-occurrence analysis and sentiment analysis of individual participants' free-text replies). First, to understand the overall participation trends, we will present the results of the quantitative analysis on reply rates. Next, to clarify the detailed communication content and emotional transitions of individual participants, we will report the results of the qualitative analysis for two participants (Participant N and Participant O) as case studies. Each utilizes a different methodology. One is a word-based co-occurrence analysis, while the other is an AI-based sentiment analysis with human correction. Through these analysis results, we will discuss the impact of Online-Kayoinoba on promoting communication and psychological well-being among participants.

Result 1. Quantitative analysis: reply rate in 2023, living alone or not living alone

As noted as one of the project's topics, we aim to enhance communication for older people, especially those living alone. *Figure 2* illustrates the average number of replies per participant from two groups: participants living alone and those not living alone (mostly with their family members, some with friends).

The number of replies per person in the Living Alone group was higher than in the Not Living Alone group for almost the entire period. The participant count gradually increased from 2021 to 2022, but remained nearly constant in 2023. Therefore, we then tested whether the number of replies varied in 2023. We examined the reply ratio, the percentage of participants who made responses in a given period. Since the total number of participants increased slightly over the period, we did not use the number of participants who made replies. The reply_ratio is (the number of participants who made replies) / (the number of all participants). The reply ratio was measured each morning for two groups of participants: those living alone and those not living alone. The number of living-alone participants was 14, the number of not-living-alone participants was 65, and the total number was 79. These are informed and approved participants for the research. Every morning, morning posts are made; thus, there are 365 posts per year. The first period was 90 days, and then there were 90 observations. The second period has 92, the third has 92, and the fourth has 92 observations. For example, on a given day, eight of the living-alone participants replied, and the reply ratio was 8/14. If twelve of the not-living-alone participants replied, the reply ratio was 12/65.

A two-way ANOVA with Aligned Rank Transform was calculated with ARtool (Elkin et al., 2021). The response variable is reply_ratio. The factors are living_alone/not_living_alone, Periods, and the interaction term of period × living_alone/not_living_alone.

ANOVA indicates that all factors, living_alone/not_living_alone ($p<0.0001$), Period ($p<0.0001$), and the interaction of period × living_alone/not_living_alone ($p<0.0001$) significantly affect differences in reply ratios. From the ANOVA, we can derive several results regarding the reply_ratio.

1. Throughout the observation period, participants who live alone consistently showed a higher reply ratio compared to those who do not live alone.

2. During the third period (July to September), the reply ratio among individuals living with their families rose. This increase may be due to

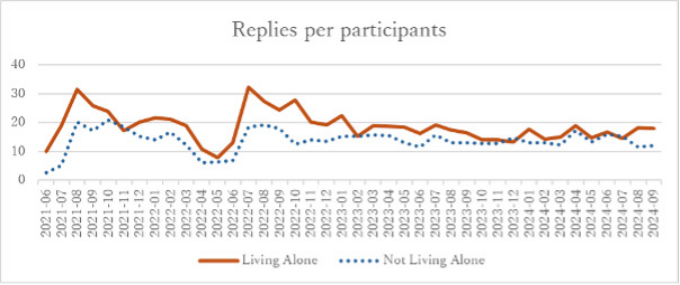

Figure 2. Average number of replies per participant from two groups: participants living alone and those not living alone

We collected 315 sentences written by Participant N between January and March 2023 and subjected them to a quantitative text analysis. The results revealed various topics and themes in Participant N's writings, including personal memories, family life, and everyday activities. This period is the cold season, and there are fewer special activities. Thus, we regard this period as reflecting her intrinsic thoughts and preferences.

various familial events commonly occurring in the summer, such as visits from extended family members, often reflected in the content of the replies.

3. In the fourth period (October to December), reply ratios were decreased among both living-alone and not-living-alone participants. This decline aligns with the year-end season, during which many participants face increased busyness and time constraints, which may affect their engagement.

The primary aim of this research, to enhance communication for older people, especially those living alone, is achieved.

Older adults who live alone often look forward to receiving messages each morning. Because of their limited social interactions, replying frequently becomes a habitual practice that many find both mentally refreshing and possibly protective against cognitive decline.

Result 2. Qualitative analysis: content analysis of individual participants' replies

The results from quantitative analysis show that these positive outcomes lead to semantic analyses for each participant. This analysis aims to identify detailed changes in each participant's responses and utilize them to help create personalized messages. We also aim to develop methodologies for detecting changes over time. Initially, we conducted an in-depth text analysis of the replies from Participant "N," a highly active member who consistently responded to nearly all roll-call messages in 2023.

Specifically, we identified three dominant themes: (1) memories of challenging times, such as her daughter's childbirth while caring for a family member with dementia; (2) interactions with her husband and mother, emphasizing the significance of social relationships in her life; and (3) subjects related to cooking and souvenirs, which arose during a trip she took in March. Additionally, our analysis uncovered distinct linguistic patterns associated with each theme, including words (highlighted in green) representing local cooking recipes, words in blue depicting reflective social and personal relationship episodes, and words in orange indicating shopping experiences.

From October to December 2023, Participant N contributed 142 sentences across 74 replies. This period marked several noteworthy developments in her life and activities. She began working part-time at a café, which she identified as a significant and positive change in her daily routine. Walking is her regular physical activity. The colder weather prompted her to take precautions to avoid catching a cold. Her concerns include topics related to her husband and friends, particularly evacuation during a disaster.

Cooking is her primary interest year-round. In winter, she enjoys visiting hot springs with friends, which she describes as her favorite seasonal activity. Moreover, reconnecting with an old friend through a LINE message brought her joy and improved her emotional well-being by renewing a treasured friendship.

Table 1. ANOVA table (Type III test): Reply ratio ~ living alone/not + period

Source of variation	DF(numerator)	DF.residual (denominator)	F-value	p-value
Living arrangement (living alone or not living alone)	1	722	1160.20	< 2.2e-16
Period (period 1–4)	3	722	8.24	2.15e-05
Interaction (living arrangement × Period)	3	722	26.91	< 2.2e-16

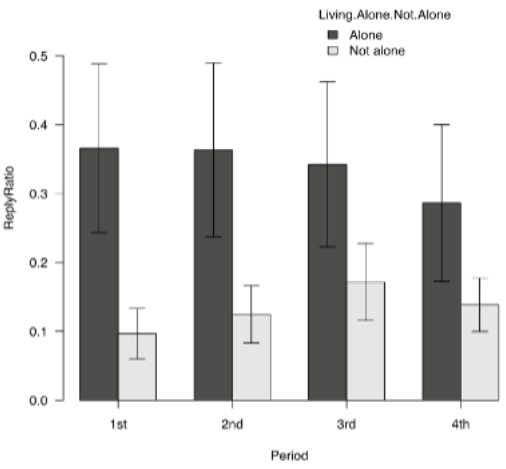

Figure 3. Reply ratios of participants living alone or not alone in the four periods of 2023

Result 3: Detailed sentiment analysis of replies by participant O

In this section, we attempted to develop and apply a detailed sentiment analysis method utilizing AI.

Considering each participant's reply tendency and in search of better conversations, we present a reply analysis of participant "O." She joined Nou-Waka 365 on June 23, 2021, and immediately became an active replier. She made 822 replies until July 2024 (the end of our survey period) and remains active in creating daily replies.

She teaches a small calligraphy class and has also represented a local "Fureai Salon," one of the voluntary circles of older people that Oita City supports. Around 250 salons are active in Oita City. Their activities include recreational, light gymnastics, tea parties, and lectures. Her late husband established the Fureai Salon in her neighborhood in 2016.

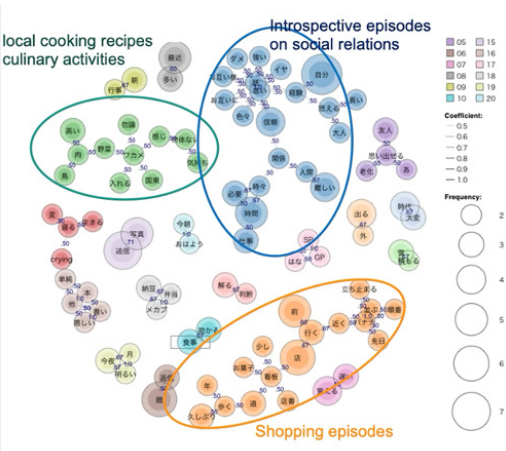

Figure 4. Word-to-word relations of participant N, January to March 2023, 141 replies, 315 sentences

In 2018, she lost her husband after fighting with his illness, and then in 2021, she lost her second son. She joined Nou-Waka 365 after these tragedies. She frequently expresses sorrow and memories of her lost family; then, she gradually regains her mind's peacefulness. Very recently, in July 2024, she lost her older sister. Although she lost replies for a short time, she soon replied actively again. The Nou-Waka activities subsidy payment from Oita Prefecture was completed in March 2024, and she continues to enjoy the Nou-Waka online community. We consider her behavior and everyday activities to have changed through participating in Nou-Waka.

Her replies are often entirely literary. She expresses mixed emotions, including grief and retrospective thoughts, before ultimately adopting a positive perspective. As stated in the aim of this research, understanding each participant's feelings and mental status is a crucial challenge for us.

Figure 6 shows the result on the timeline since she joined Nou-Waka 365. Because Anger and Disgust have low values, they are not plotted in the figures.

The sentiment analysis results revealed three findings. 1. Throughout the entire period, Trust, Surprise, and Joy increased after several weeks following a surge of Sadness and/or Anxiety. They are engaging in some mental balancing acts. 2. Acceptance has two months of cycles in 2023. It reflects her older sister's death in July and her poor health in June. Reading her message, replying to Nou-Waka seems to have become a habit. She is accepting her circumstances by remembering the deceased and writing to them. In particular, the part where the acceptance score is high is when she remembers the deceased, endures the pain, and accepts life. 3. Seasonal variations are shown. The year-end and new-year seasons tend to have fewer replies due to the many family and social events.

Discussion

The Ministry of Health, Labour, and Welfare introduced "Kayoinoba" community gathering salons in 2014. Oita prefecture achieved the highest participation rate in Japan. To adapt to changing social situations, Online-Kayoinoba was launched in April 2021 and funded until March 2024. The Nou-Waka 365 (Somelight Co., Ltd.)

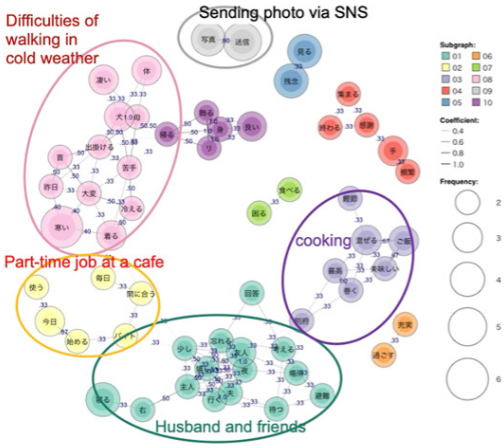

Figure 5. Word-to-word relations of participant N, October to December 2023, 74 replies, 142 sentences

chat communication platform on LINE SNS was implemented as the online medium. Participants receive daily mass messages with seasonal greetings, health advice, and they can respond voluntarily. Staff provide personalized replies, following guidelines that prioritize participant comfort and safety. The platform promotes social activities, independent living, and healthy life expectancy. By leveraging technology, Online-Kayoinoba expands community-based initiatives, fostering collaboration among residents and generations. This approach could enhance the quality of life (QOL) for older people in Oita prefecture.

This project has two topics. 1. Is it practical to deal with the crisis of the loss of opportunities for everyday interaction in the community due to the coronavirus pandemic? The risk of communication loss is particularly high for older individuals living alone, and this study aims to investigate whether it is possible to enhance communication. 2. Detect the detailed changes in each participant's reply and use them to help create personalized messages. We would also like to develop a methodology to detect changes over time.

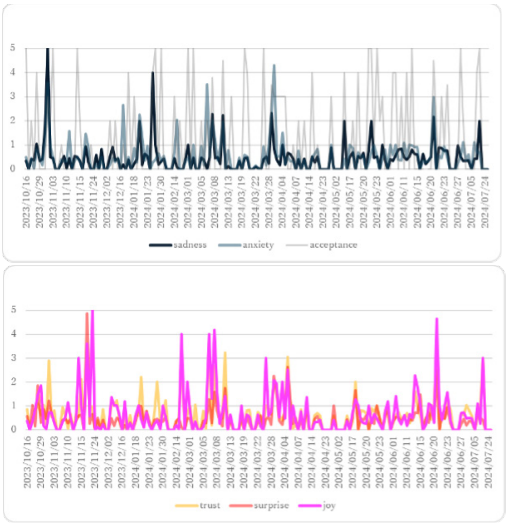

Figure 6. Detailed sentiment analysis result of replies from Participant O, from Oct 2023 to July 2024

The number of replies per person in the Living Alone group was higher than that in the Not Living Alone group for almost the entire period. The participant count gradually increased from 2021 to 2022 but remained nearly stable in 2023. Therefore, we tested whether the number of replies differed between the two groups in 2023. We examined the reply ratio, which is the percentage of participants who responded to all individuals during a specific period. ANOVA results indicate that Living Alone participants have a statistically higher reply ratio throughout the year than Not Living Alone participants. During the summer, participants living with their families increased the response ratio due to family events. At the end of the year, both the Living Alone and Not Living Alone groups decreased their replies due to year-end activities.

Although there are seasonal surges, there is a consistently high reply rate among older adults living alone. There are two possible reasons. First, the Nou-waka staff closely examines the relevant replies and tailors responses to each individual's circumstances. These circumstances may include details regarding recent bereavement or the presence of family members returning home. Second, older adults who live alone often anticipate receiving messages each morning. As they have limited daily interactions, replying becomes a habitual practice that many describe as mentally refreshing, with some noting that it may help delay cognitive decline. Indeed, several individuals have reported enhanced ability to speak in public—despite previous difficulties—and attribute improvements in cognitive function test performance at senior citizen training courses to their regular participation.

We have word-based co-occurrence analyses of the replies from the highly active participant "N." The analysis results provide valuable insights into Participant "N"'s engagement patterns and interests and have implications for our interaction. The emergence of various themes and topics in her replies suggests a complex and multifaceted individual with diverse concerns and passions. The text analysis approach offers a nuanced understanding of the linguistic patterns employed

by highly active participants. The findings underscore the importance of considering the contextual factors that influence online communication, including the roles of social relationships, community norms, and individual personality traits. Tracking personal favorite activities and seasonal changes helps personalize staff replies and keep participants motivated.

We also have another approach to analyzing the detailed sentiments of active participants' replies. Participant O has been actively replying since joining Nou-Waka in June 2021. She had several tragedies: she lost her husband in 2018, her son in 2021, and her older sister in July 2024. Her responses are literary and express a mix of grief, reflective thoughts, and a positive outlook. Since standard sentiment analysis methods only estimate positive or negative sentiment, they are inadequate for such mixed-emotion expressions. We utilized a Japanese sentiment dictionary, morphological analysis, and a lookup program to estimate sentiments. This AI-based analysis procedure lacked sufficient accuracy, so we manually refined the result. We have identified self-recovery tendencies in her replies. Trust, surprise, and joy increased after several weeks, following a surge of sadness and anxiety. This sentiment analysis could be applied to more participants to explore their mental health. Another focus is on the expressions of "Acceptance." The loss of a loved one is not uncommon in the lives of older people. Such painful events can lead to depressive tendencies.

Participant O has consistently expressed acceptance of sad life events and recovery. Concerning mental health status is also essential, along with making personalized replies.

Why do participants reply every day? Since it is free for them, there is no reason to use Nou-waka 365 to get their money's worth. The following phenomena are often observed: Participants reflect before responding as they consider ideas for each daily theme. This reflection allows them to express thoughts they might not otherwise share. The acceptance and understanding they receive from others contribute to their mental stability and sense of renewal. The phrase "I wonder what today will be like" frequently appears in questionnaires. Even if participants do not respond, they have developed a routine of checking the messages daily.

Limitations of the study

Several limitations should be acknowledged. First, the sample was drawn from a specific region (Oita Prefecture) and included only those who provided informed consent, which may limit the generalizability of the findings. The study may therefore underrepresent those with severe health or cognitive issues or limited access to technology.

Second, from a methodological perspective, the assumptions of normality required for ANOVA may not be fully met. Future research may consider non-parametric alternatives where appropriate. In the sentiment analysis, the limitations of AI in detecting mixed emotional expressions were evident. Approximately 40% of the AI-estimated results required manual correction, suggesting that hybrid approaches remain necessary. Additionally, the qualitative analysis was based on a small number of case studies, which limited its broader applicability.

Finally, the study was conducted during the COVID-19 pandemic, a period in which external social contact was highly restricted. This context likely influenced participants' motivation to engage in digital communication and may not fully reflect typical behaviors in non-pandemic conditions.

Further research directions

While this study has illuminated the effectiveness of Online-Kayoinoba in promoting social activities, independent living, and healthy life expectancy among older people and individuals in Oita prefecture, several avenues for further research remain.

1. Longitudinal analysis: A more extensive longitudinal analysis could examine the long-term effects of Online-Kayoinoba on participants' mental health, cognitive function, and overall quality of life.

2. Comparison with other platforms: Comparative studies could evaluate the effectiveness of various platforms (e.g., those providing online chat versus those that do not) in fostering social engagement and community-based initiatives among older people.

3. Personalization and tailored responses: Further research could develop more advanced methodologies for detecting changes in participants' responses over time and crafting personalized messages that address their individual needs and interests.

4. Expansion to different demographics: The Online-Kayoinoba platform could be adapted to other demographics, such as younger adults or individuals with disabilities, to explore its potential benefits across different age groups and populations.

5. Mental health analysis: More in-depth sentiment analyses could be conducted on a larger sample of participants to gain a deeper understanding of the mental health benefits and challenges associated with participating in Online-Kayoinoba.

6. Community engagement and social capital: Research could examine the effects of Online-Kayoinoba on community engagement, social capital, and the development of social relationships among participants.

By pursuing these research directions, we can further refine our understanding of the potential benefits and limitations of online community-based initiatives, such as Online-Kayoinoba, and develop more effective strategies for promoting healthy aging and social engagement among older individuals.

Conclusion

This study investigates Online-Kayoinoba, an online community-based initiative implemented in Oita Prefecture since 2021. The program utilizes the Nou-Waka 365 chat communication system on LINE SNS to connect seniors with their local communities and facilitate activities. Its objectives are to promote social participation, support independent living, and extend the healthy life expectancy of older adults, including those living alone. Participants receive daily mass messages in the morning and can provide voluntary, personalized responses.

Quantitative analysis revealed that older adults living alone showed a significantly higher reply ratio than those not living alone across all observed periods. This finding suggests that individuals with fewer daily social interactions may be more motivated to engage in routine communication when given accessible and low-pressure tools, such as Online-Kayoinoba. The platform provided not only a means of communication but also an opportunity to maintain a daily rhythm and connection to others, potentially contributing to the alleviation of social isolation.

The co-occurrence word analysis of Participant N's responses revealed seasonal patterns and recurring themes, including her health concerns, family, daily routines, and interpersonal relationships. These insights reflect individual interests and provide a foundation for tailoring content to sustain motivation and engagement. Similarly, the sentiment analysis of Participant O's responses demonstrated a complex emotional trajectory that included grief, anxiety, and eventual emotional recovery, emphasizing the role of Online-Kayoinoba in supporting mental health through empathetic engagement.

Further research will be conducted in different areas, and tailored response messages will be developed based on participants' physical and mental health status.

Research ethics procedure

When they joined Online-Kayoinoba, all participants returned the written agreement for the use of response data in the research, following the regulations set by the Oita Prefectural Office. Additionally, a consent letter for data analysis was issued in December 2023, and participants were asked to either agree or disagree with the use of their data in the research. Seventy-nine participants returned the signed agreement. The data from these consenting participants were analyzed in this study. This study received ethical approval from the ethics committee of the Oita prefectural office with the approval number 2-13.

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