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Digital health and physical activity: Insights from advanced lung cancer patients in Hong Kong

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ABSTRACT

Objective: This study explored knowledge of physical activity (PA) benefits, practices, preferences, and the acceptability of instant messaging interventions among patients with advanced lung cancer (ALC).
Methods: A cross-sectional survey was conducted using non-probability convenience sampling at a major regional teaching hospital in Hong Kong.
Results: Of 100 participants approached, 82 ALC patients (mean age 64 years; 46.3% male) were included. Most believed PA could alleviate fatigue (72.0%), improve mood (72.0%), enhance sleep (65.9%), and relieve cancer-related discomfort (53.7%). However, only 34.1% were informed about PA benefits by health professionals, and 28.0% actively sought PA information. While 91.5% and 42.7% of ALC patients considered light and moderate PA, respectively, PA engagement declined, with those meeting the recommended 150 minutes of moderate PA per week dropping from 52.4% pre-diagnosis to 22.0% post-diagnosis. Among participants, 78.0% owned smartphones, and 92.2% of these had messaging apps. Most (81.3%) found it was feasible to use instant messaging for cancer-related information, and 71.9% believed health messages could encourage PA. Preferred topics included dietary information (85.9%), cancer treatments (70.3%), PA (67.2%), and infection prevention (35.9%). Most preferred receiving 1–3 messages per week (76.6%), especially in the afternoon (57.8%).
Conclusions: This study highlights gaps between ALC patients' positive beliefs about PA and health care providers' engagement, as well as deficiencies in health knowledge and behavior. Integrating PA guidance into routine care could support ALC patients' physical and mental well-being. Future research should explore smartphone-based messaging interventions to deliver personalized health education, promote PA, and improve outcomes.
Trial registration: ClinicalTrials.gov NCT04104516.

Introduction

Lung cancer is the most common cancer globally[1] and the second most common in Hong Kong.[2] Nearly half of lung cancer patients were diagnosed at an advanced stage, encompassing both stage III (locally advanced, with extensive spread within the chest) and stage IV (metastasis, spreads to distant sites beyond the chest).[3] Physical activity has been proposed as an alternative treatment to alleviate cancer- and treatment-related discomfort.[4] The potential mechanisms behind the positive effects of physical activity include modulation of insulin, antioxidant mechanisms, inflammatory responses, and pulmonary ventilation.[5]

Four systematic reviews (2019–2023)[6–9] of 26 randomized controlled trials (RCTs) involving 1537 patients reported significant benefits of physical activity for adults with lung cancer in the intervention groups. However, few of them specifically involved patients with advanced lung cancer (ALC). Benefits of physical activity include maintaining or enhancing exercise capacity[6] and improving quadriceps

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muscle strength,[7] which aids overall mobility in lung cancer patients. Physical activity has also been shown to improve disease-specific global health-related quality of life,[6–9] physical well-being[8] and reducing dyspnea.[7] Understanding lung cancer patients' physical activity preferences is essential so that health care providers can develop personalized, patient-centered programs. Such programs could enhance patient participation, improve treatment and exercise adherence, and ultimately boost overall well-being.[10]

Instant messaging platforms (e.g., WhatsApp, WeChat) are popular and cost-effective tools for promoting health knowledge, raising awareness, and encouraging healthy practices. Their adaptability, scalability, and affordability make them particularly suitable for delivering health interventions.[11] The role of technology in managing chronic diseases, such as asthma and chronic obstructive airway disease, has already been explored, highlighting the potential of digital solutions in improving health outcomes.[12] One of the key advantages of instant messaging platforms over other digital modalities is their familiarity among diverse populations, including older adults. Many patients are already accustomed to using these platforms for personal communication, which minimizes the need for extensive training or onboarding. Unlike specialized health apps or websites that often require downloading, registration, or navigating complex interfaces, instant messaging offers a straightforward and user-friendly experience, making it accessible to individuals with varying levels of digital literacy. Moreover, instant messaging enables real-time communication, allowing patients to receive timely reminders, motivational messages, and educational content. This immediacy is particularly valuable for promoting adherence to physical activity recommendations, as patients can be encouraged and supported at critical moments throughout their day. By leveraging the simplicity and accessibility of instant messaging, health care providers can deliver tailored interventions that seamlessly integrate into patients' daily routines, ultimately enhancing engagement and improving health outcomes. A systematic review suggested that using instant messaging for cancer management might improve various physical and psychosocial health outcomes among oncology patients.[13]

However, our search of PubMed and the Cochrane Library on November 11, 2024, using keywords such as "lung cancer" and "instant messaging," found no articles addressing e-information preferences or messaging interventions for lung cancer patients. We identified only one qualitative study on lung cancer patients' perspectives on telerehabilitation following curative intent therapy. This study highlighted the need to enhance telemedicine skills and self-efficacy in using digital health technologies.[14] Additionally, Dunn et al.[15] reported that the number of clinical efficacy studies on digital health technologies remains relatively small. Therefore, evaluating the clinical effectiveness of digital health technologies in improving health outcomes in real-world settings is urgently needed.

Hong Kong, one of the most urbanized and westernized cities in China, has widespread internet and ICT penetration, with 96.3% of individuals owning smartphones.[16] Given this high mobile penetration rate, leveraging mobile instant messaging to enhance physical activity could be an innovative and cost-effective strategy to promote physical activity among ALC patients. Although the positive effects of physical activity on health outcomes are well-documented, and the importance of leveraging information and communication technology (ICT) is widely recognized, there is limited understanding of whether ALC patients, particularly older individuals, are willing to accept and engage with physical activity interventions delivered through mobile instant messaging platforms. This gap highlights the need for research exploring the feasibility of promoting physical activity and the acceptance, instant messaging interventions among ALC patients.

This study explored ALC patients' knowledge of the health benefits of physical activity, their physical activity practices and preferences, and the acceptability of instant messaging interventions. A systematic literature review on health literacy and older adults has identified several age-related changes that may contribute to a decline in health literacy. Besides, education also plays a significant role in shaping health literacy.[17] For example, cognitive decline in older adults can impair their ability to comprehend and/or retain new information.[17] Additionally, older adults with cancer have been shown to have significantly lower eHealth literacy.[18] Higher educational levels appear to positively influence digital health literacy.[19] Based on these findings, it was hypothesized that younger patients and those with higher education levels would have a better understanding of the health benefits of physical activity compared to older patients and those with lower education levels, respectively. The findings can inform the development of a smartphone-based, patient-centered physical activity and self-management support intervention aimed at improving patient outcomes and reducing the health care burden.

Methods

Study design and setting

This study employed a cross-sectional, interviewer-administered survey using non-probability convenience sampling, with the goal of recruiting 100 patients diagnosed with lung cancer. The primary objective was to gather insights that would inform the development of smartphone-based physical activity and self-management interventions tailored for ALC patients in Hong Kong. The survey was conducted in the inpatient ward and specialty outpatient clinic of a major regional teaching hospital in Hong Kong, spanning the period from September 2019 to June 2020. However, data collection was temporarily disrupted between February and April 2020 due to several factors. These factors included hospital restrictions on non-essential procedures because of the impact of the COVID-19 pandemic and the increased workload within the hospital. The Institutional Review Board (IRB) of The University of Hong Kong/Hospital Authority Hong Kong West Cluster (HKW) approved the research protocol (HKW IRB No. UW 19–597). The study was also registered with the National Institutes of Health (Identifier: NCT04104516). All participants provided written informed consent. To ensure data confidentiality, personal information was removed from data files and stored separately under more stringent security measures (i.e., an assigned area with a lock). All personal data is accessible to authorised persons. All data was kept encrypted, with controlled access and anonymization.

Participants

The inclusion criteria were: (i) aged 18 or above, (ii) diagnosed with ALC, and (iii) able to speak and read Chinese. ALC refers to lung cancer that has spread significantly from its origin, typically including Stage III (locally advanced, with extensive spread within the chest) and Stage IV (metastatic, spread to distant sites beyond the chest). We excluded those diagnosed as early-stage or unknown-stage lung cancer.

Written informed consent was obtained after researchers thoroughly explained the study's purpose and data collection methods to ensure patients understood that their standard care would not be affected. Patients who were unable to complete the questionnaire independently due to physical limitations (e.g., poor eyesight) were assisted by an interviewer. No incentives were provided to participants. All participants gave written informed consent.

Research working committee, comprising a physiotherapist (DYSY), an advanced practice nurse (AYKL) and three ALC patients, was established to formulate questions in four areas: (i) knowledge about the benefits of physical activity on health, (ii) physical activity practices, (iii) physical activity preferences, and (iv) the acceptability on instant messaging interventions. When formulating these questions, expert opinions from physiotherapists and nurses working in oncology care were sought, and three face-to-face individual meetings with three ALC patients were conducted to understand patients' personal experience with physical activity preferences and practices. A pilot test was

conducted with another five ALC patients to gather feedback on the applicability and understandability of the questions, as well as the length of the questionnaire. The questionnaire was subsequently refined for the present survey.

For the sample size, we referenced a similar study on physical activity preferences among patients with lung cancer.[20] However, due to hospital restrictions imposed in response to the high prevalence of COVID-19, we were unable to proceed with our study as planned. Furthermore, we recognize that no formal power or sample size calculations were conducted, which further limits the generalizability of our findings.

Variables and measurements

Participants' characteristics

Demographic information and medical history were retrieved from patients' hospital records. This included sex, age, body mass index, marital status, education level, employment status, living arrangement, smoking and drinking habits, duration since diagnosis, medical history, types of metastases, cancer stage, and current treatments.

Knowledge on the benefits and discussion regarding physical activity on health

Participants were asked five questions about their knowledge of the health benefits of regular physical activity, including whether it could improve general health status, alleviate side effects from cancer and treatment-related discomfort, reduce fatigue, enhance sleep quality, and boost mood. Additionally, one question assessed their knowledge of the association between sedentary behaviour and cancer risks. The response options for each question were "Yes," "No," and "Do not know." Participants were also asked two questions about sourcing physical activity information: "Have health professionals talked with you about the positive effects of physical activity in relieving cancer- and treatment-related discomfort?" and "Did you proactively look for information on physical activity related to cancer and its treatment?" The response options for these questions were likewise "Yes," "No," and "Do not know."

Physical activity practices before and after being diagnosed with lung cancer

Participants were asked whether they habitually engaged in 150 minutes of moderate physical activity per week prior to their cancer diagnosis, with response options of "Yes," "No," and "Do not know." To assess current physical activity practices after their cancer diagnosis, questions were adapted from the short form of the International Physical Activity Questionnaire – Chinese version (IPAQ-C). The intraclass correlation coefficient of IPAQ-C is 0.79.[21]

Participants were asked to self-report the number of days and the amount of time they engaged in moderate and vigorous physical activity. The questions included: "During the last 7 days, how many days did you do at least 10 minutes of moderate/vigorous physical activity?" and "How much time did you usually spend doing moderate/vigorous physical activity on one of those days?" Additionally, an outcome-based question was asked about the venue of exercise in the past month, with options including "Home," "Gym room," "Community centre," "Outdoors," and "Cancer centre."

Preferred physical activity intensity, schedule, and time of day to perform physical activity, categories, and types of physical activity

Participants were asked three questions about whether they considered themselves capable of performing physical activities of different intensities, including light, moderate, and vigorous intensity. The response options for each question were "Yes," "No," and "Do not know." Additionally, two questions explored participants' preferences regarding their physical activity schedule and the time of day for performing physical activities. Schedule preferences included "Designed by themselves," "Designed by health care professionals," and "No preference." Time-of-day preferences included "Early morning," "Late morning," "Lunchtime," "Afternoon," "Before dinner time," "After dinner time," "Before bedtime," and "No specific preference," with participants allowed to select multiple options. Two more questions addressed preferences for physical activity categories and types. Physical activity category options included "Cardiopulmonary exercise (e.g., walking)," "Balance exercise (e.g., single-leg stance)," "Strength training (e.g., grip strength)," "Stretching exercise (e.g., sit and reach exercise)," "Breathing exercise (e.g., mindfulness breathing)," and "No idea." Exercise type options included "Home-based exercise," "Running," "Jogging," "Brisk walking," "Cycling," "Gym-based exercise," "Dancing," "Yoga," "Qigong," and "Tai Chi." Participants were allowed to select multiple options for both categories and types.

Acceptability of instant messaging interventions

Participants were asked whether they owned mobile phones capable of installing instant messaging apps, with response options of "Yes" and "No." Follow-up questions inquired whether instant messaging Apps (such as WhatsApp or WeChat) were installed on their phones, with the same response options. The acceptability of instant messaging interventions was assessed using three questions: "Do you think it is effective to use instant messaging (such as WhatsApp or WeChat) to provide cancer-related information to patients?" "Do you think it is feasible to use instant messaging (such as WhatsApp or WeChat) to respond to or discuss cancer-related inquiries with patients?" and "Do you believe health-related e-messages can remind you to exercise regularly?" The response options for each question were "Yes," "No," and "Do not know."

Participants were also asked about their preferred types of information to receive, with options including cancer and its treatment, physical activity, dietary choices, infection control, weight control, emotional management, psychological support and counselling, and financial management. Multiple selections were allowed. Preferences for the timing and frequency of receiving instant messages were also assessed. For the timing, participants were asked, "Which period of the day do you think is best to receive health-related e-messages?" with options of "morning," "afternoon," "evening," and "night," allowing multiple selections. For the frequency, participants answered, "How many days a week would you like to receive health-related e-messages?" with options of "1–3 days," "4–5 days," and "6–7 days," where only one option could be selected.

Statistical analysis

Data analysis was conducted using the SPSS 25 software package (SPSS, Chicago, Illinois), employing both descriptive and inferential statistical methods. A p-value of less than 0.05 ($P < 0.05$) was considered statistically significant. Descriptive statistics were used to summarize key features of the dataset, including frequencies and percentages to describe participants' characteristics, knowledge of the benefits of physical activity, physical activity practices, preferences for physical activity, and the acceptability of instant messaging interventions.

To examine associations, the χ^2 test and binary logistic regression were utilized. These analyses explored the relationship between participants' knowledge of the health benefits of physical activity and their age groups (< 65 years vs. ≥ 65 years) as well as their education levels (primary or below vs. secondary or above). The analyses were conducted both without and with mutual adjustments for potential confounding variables, including sex, age group, and education level group, respectively.

Results

Participants' characteristics

Fig. 1 shows the patient recruitment flow. A total of 133 lung cancer patients were either admitted to the hospital or attended medical appointments during the recruitment period. Of these, 33 patients could not be approached due to logistical challenges, including patients being engaged in other procedures when visiting them ($n = 16$) and staff who were responsible for recruitment being occupied with other responsibilities ($n = 17$) when patients were in the hospital. The remaining 100 patients were successfully approached for participation in the study. One patient refused to participate, 14 were found to have early-stage lung cancer, and the staging was unknown for three patients. Therefore, the remaining 82 patients with ALC were included in this survey.

Table 1 shows that the mean age was 64 years, with 46.3% being male. Among the participants, 78.0% were married, and 76.8% had at least a secondary education. The majority (85.4%) were living with family or others. 20.8% were employed. Additionally, 29.3% had a history of hypertension, while 19.5% and 13.4% had a history of hyperlipidaemia and diabetes, respectively. Regarding smoking history, 65.9% had never smoked, while 25.6% were current smokers and 8.5% were ex-smokers. Regarding drinking history, 76.8% were never drinkers, while 11.2% were current drinkers and 11.0% were ex-drinkers. The median time since diagnosis was 26.5 months. Of the participants, 67.1% were diagnosed with Stage 4 lung cancer, and 39.0%, 19.5%, and 4.9% of them had bone, brain, and liver metastases, respectively. In terms of ongoing treatment, 50.0% were receiving targeted therapy, while 40.2% were undergoing chemotherapy.

Knowledge on the benefits and discussion regarding physical activity on health with health professionals

Table 2 shows that 28.0% of the participants believed that sedentary behaviour was associated with cancer risks. 72.0% thought regular physical activity could alleviate fatigue and improve mood, and 65.9% believed it could enhance sleep quality. Furthermore, 53.7% believed it could relieve cancer-related discomfort and its treatments. There was no significant difference in patients' knowledge of the benefits of physical activity on their health between age groups (< 65 years vs. ≥ 65 years) and education level groups (primary education or below vs. secondary education or above).

Despite these positive beliefs, Fig. 2 shows that only 34.0% have been approached by health professionals to proactively discuss the benefits of physical activity on health, cancer-related symptoms, and side effects of treatment, and 34.0% actively looked for physical activity information by themselves during their cancer journey.

Physical activity practices before and after being diagnosed with lung cancer

Before their cancer diagnosis, 52.4% of participants reported engaging in at least 150 minutes of moderate physical activity per week. Regarding their current physical activity levels, Fig. 3a indicates that, over the past seven days, only 22.0% of participants engaged in at least 150 minutes of moderate physical activity, and 7.3% engaged in at least 75 minutes of vigorous physical activity.

Fig. 3b highlights the venues where participants performed physical activity in the last month. The most common locations were outdoors (61.1%) and at home (50.0%). In contrast, only a small percentage of participants reported regular physical activity in gym rooms (6.1%), community centres (2.4%), and cancer centres (1.2%).

Preferred physical activity intensity, schedule, and time of day of performing physical activity, categories, and types of physical activity

Fig. 4a shows that the vast majority of participants (91.5%) consider themselves suitable for light physical activity, while 42.7% feel capable of engaging in moderate physical activity. However, only 7.3% believe they can handle vigorous physical activity. Regarding scheduling preferences, Fig. 4b indicates that most participants (54.9%) prefer a self-directed approach to planning their physical activity. This is followed by 26.8% who have no specific preference, while the remaining participants (18.3%) prefer schedules designed by health care professionals. In terms of timing, Fig. 4c reveals that 43.9% and 36.6% of participants prefer exercising in the early morning and late morning, respectively. Fig. 5a reveals that cardiopulmonary exercises were the most popular, favoured by 84.1% of participants, followed by stretching exercises (47.6%) and breathing exercises (45.1%). Similarly, Fig. 5b highlights that brisk walking exercise (56.1%) was the most frequently chosen.

Acceptability of instant messaging interventions

Table 3 shows that 78.0% of all participants owned smartphones. Among smartphone owners, 92.2% installed instant messaging Apps. Additionally, 81.3% believed it was feasible to use instant messaging to provide and respond to cancer-related information, and 71.9% agreed that health-related e-messages could remind them to engage in physical activity.

The most preferred type of information was dietary information (85.9%), followed by cancer-related treatment (70.3%), physical activity (67.2%), and infection prevention (35.9%). Over half of the participants (57.8%) preferred to receive e-messages in the afternoon, while 76.6% favoured receiving 1–3 e-messages per week.

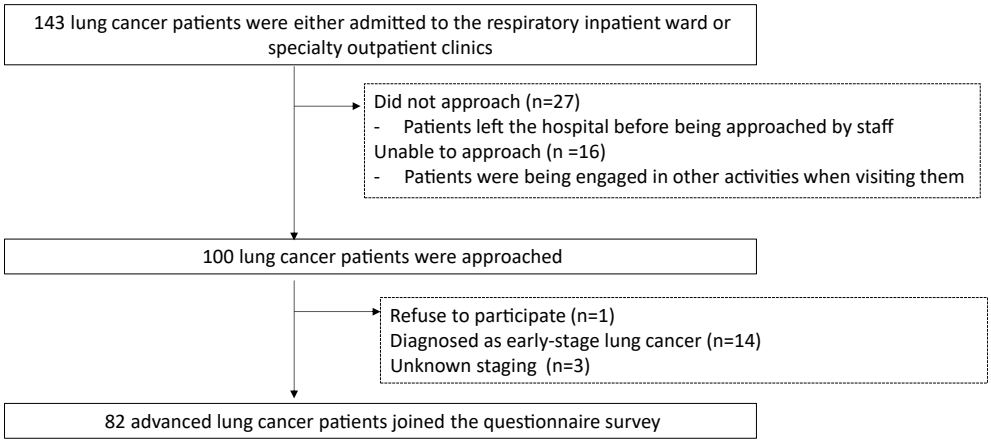

Fig. 1. The recruitment flow.

Table 1
Characteristics of those advanced lung cancer patients who joined the survey ($N = 82$).

Variable	*n* (%)
Sex	
Male	38 (46.3)
Female	44 (53.7)
Age, years [a]	63.8 ± 11.1
Body mass index, kg/m^2 [a]	22.9 ± 3.6
Marital status	
Never married	13 (15.9)
Married	64 (78.0)
Widowed/Divorced	5 (6.1)
Education level	
Primary or below	31 (37.8)
Secondary	32 (39.0)
Tertiary or above	19 (23.2)
Living arrangement	
Alone	12 (14.6)
Living with family/others	70 (85.4)
Employment	
Employed, part-time	9 (11.0)
Employed, full time	8 (9.8)
Unemployed	11 (13.4)
Retired	43 (52.4)
Homemaker	11 (13.4)
Smoking	
Current smoker	7 (8.5)
Ex-smoker	21 (25.6)
Never smoker	54 (65.9)
Drinking	
Current drinker	10 (11.2)
Ex-drinker	9 (11.0)
Never drinker	63 (76.8)
Medical history	
Hypertension	24 (29.3)
Hyperlipidaemia	16 (19.5)
Diabetes	11 (13.4)
Heart disease	4 (4.9)
Chronic obstructive pulmonary disease	4 (4.9)
Asthma	1 (1.2)
Stroke	2 (2.4)
Number of months since diagnosis [b]	26.5 (9.8, 45.0)
Stage of cancer	
Stage 3a	3 (3.7)
Stage 3b	24 (29.3)
Stage 4	55 (67.1)
Metastasis [c]	
Bone	32 (39.0)
Brain	16 (19.5)
Liver	4 (4.9)
Breast	1 (1.2)
Pancreas	1 (1.2)
Colon	1 (1.2)
On-going treatment	
No active treatment	5 (6.1)
Radiotherapy	1 (1.2)
Chemotherapy	33 (40.2)
Targeted therapy	41 (50.0)
Immunotherapy	1 (1.2)

[a] Presented as mean ± standard deviation.
[b] Presented as median (interquartile range).

Discussion

Supporting self-management through personalized and digital interventions

We have first shown a remarkable gap between participants' positive beliefs about the benefits of physical activity and health care providers' proactive engagement in encouraging their patients to participate in physical activity during the cancer journey. After a cancer diagnosis, many participants experienced a significant decline in physical activity levels. Despite this, participants preferred light and moderate activities, emphasizing flexibility in scheduling and various preferred exercise types. Instant messaging was well-accepted for receiving health-related information. Understanding these needs and preferences will aid in designing and implementing physical activity and self-management programs for ALC patients.

In our cohort, we found no statistically significant differences in knowledge of the benefits of physical activity across different age groups or education levels. This allowed us to interpret our findings as not requiring further sub-analysis. Nonetheless, given the small sample size and the single-centre sampling approach, we acknowledge the need for cautious interpretation of our results. These limitations suggest that our findings might not fully represent the broader population.

Our findings showed that 78.0% of participants recognized the benefits of physical activity in improving overall health. However, only 22.0% engaged in at least 150 minutes of moderate physical activity per week, revealing a significant knowledge-behaviour gap. A 2023 review similarly reported a discrepancy between beliefs in the health benefits of physical activity and actual engagement in regular physical activity.[22] Barriers such as lack of support from health care professionals and fear of worsening symptoms were identified as significant contributors.[23] Additionally, our study found that only 34.1% of participants had been proactively approached by health care professionals to discuss the potential benefits of physical activity. Similar findings have been reported, showing that despite the well-documented benefits of physical activity in alleviating the effects of cancer and its treatment, health care providers do not routinely discuss exercise with their patients.[24] This may be attributed to factors such as a lack of knowledge, time constraints, and concerns about safety when recommending physical activity to ALC patients. Studies have shown that approximately 80% of health care professionals are unaware of exercise guidelines for cancer patients and lack sufficient knowledge on when, how, and which patients to refer to physical activity programs.[24] To address these challenges, combined education and collaborative training for medical, nursing, and allied health professionals may enhance the quality of cancer care. Inter-professional education and training can promote awareness of the importance of physical activity among cancer patients.[25]

Our findings showed a significant decline in physical activity levels following their cancer diagnosis. Such a decline may be explained by the symptom burden and lack of support from the cancer and treatment journey. Researchers reported that cancer-related fatigue, dyspnoea, and difficulty with daily activities were the most common barriers to physical activity.[26] Psychosocial barriers included low motivation and kinesiophobia, and perceived health benefits and social support/guidance by health care providers were significant facilitators.[27] These barriers can be compounded by insufficient education, leading to misconceptions about the benefits of exercise during treatment.[28] Inadequate patient education may contribute to the belief that exercise is not helpful when experiencing side effects of treatment, including fatigue. Thus, health care institutions and policymakers could better implement guidelines and develop a standardized process to direct all cancer patients to appropriate physical activity resources tailored to their needs.[29]

Our participants strongly preferred light and moderate activities, favoring flexible scheduling, a self-planned approach, and morning routines. A review emphasized the importance of tailoring exercise to individual needs and conditions, highlighting that there is no one-size-fits-all solution.[30] The Zero-Time Exercise (ZTEx) approach offers a practical solution by incorporating simple, equipment-free exercises into daily life, promoting movement without extra time or cost, which has been used in promoting physical activity and fitness in patients with coronary heart disease.[31] Examples include pedaling while sitting and standing on one leg while watching movie at home. More examples can be found in our YouTube videos.[31] This method aligns with guidelines from the American Physical Activity Guidelines, which advocate for increased activity, stating that moving more and sitting less is beneficial for nearly everyone and that some physical activity is better than none.[32]

Our findings indicate that over 70% of participants believe health messages can encourage physical activity. Mobile text reminders play a

Table 2
Knowledge on the benefits from physical activity on their health in all participants and subgroups.

Items		Age group[a]				Education level group[b]			
	All	< 65 years old	≥ 65 years old	Crude[c]	Adjusted[d]	Primary education or below	Secondary education or above	Crude[c]	Adjusted[d]
	(*N* = 82)	(*n* = 41)	(*n* = 41)			(*n* = 31)	(*n* = 51)		
	N (%)	*n* (%)	*n* (%)	Odd ratio (95% CI); *P*-value	Odd ratio (95% CI); *P*-value	*n* (%)	*n* (%)	Odd Ratio (95% CI); *P*-value	Odd ratio (95% CI); *P*-value
Sedentary behaviour is associated with cancer risks	23 (28.0)	12 (29.3)	11 (26.8)	0.87 (0.34, 2.32); 0.81	1.11 (0.38, 3.25); 0.84	7 (22.6)	16 (31.4)	1.57 (0.56, 4.39); 0.39	1.99 (0.62, 6.39); 0.25
Regular PA can improve mood	59 (72.0)	30 (73.2)	29 (70.7)	0.89 (0.34, 2.32); 0.81	1.03 (0.35, 3.04); 0.95	21 (67.7)	38 (74.5)	1.39 (0.52, 3.72); 0.51	1.47 (0.48, 4.52); 0.50
Regular PA can improve fatigue	59 (72.0)	29 (70.7)	30 (73.2)	1.13 (0.43, 2.96); 0.81	1.29 (0.43, 3.91); 0.65	22 (71.0)	37 (72.5)	1.08 (0.42, 2.91); 0.88	1.51 (0.47, 4.88); 0.49
Regular PA can enhance sleep quality	54 (65.9)	29 (70.7)	25 (61.0)	0.65 (0.26, 1.62); 0.35	0.63 (0.22, 1.81); 0.40	20 (64.5)	34 (66.7)	1.10 (0.43, 2.81); 0.84	1.13 (0.37, 3.41); 0.83
Regular PA can alleviate cancer- and treatment-related discomfort	44 (53.7)	21 (51.2)	23 (56.1)	1.22 (0.51, 2.90); 0.66	1.03 (0.35, 3.04); 0.95	14 (45.2)	30 (58.8)	1.74 (0.71, 4.27); 0.23	1.03 (0.35, 3.04); 0.95

No significant difference was found in the between-group comparisons without or with adjustment of potential confounding factors. PA, physical activity.
[a] Age group = less than 65 years old versus 65 years old or older.
[b] Education level group = primary education or below versus secondary education or above.
[c] Chi-square was used to estimate the crude odd ratio between 2 groups.
[d] Binary logistic regression was used to estimate the adjusted odd ratio between 2 groups with mutual adjustment of potential confounding factors including sex, age group and education level group.

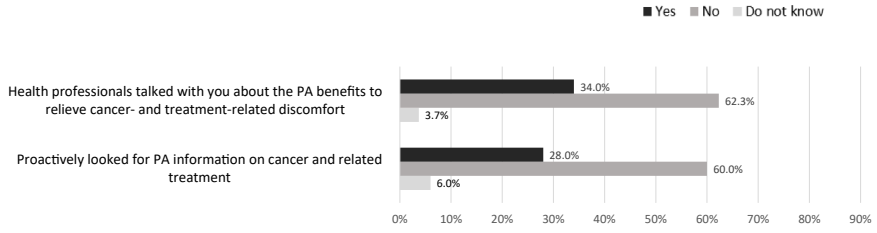

Fig. 2. Discussion with health care professionals regarding physical activity on health.

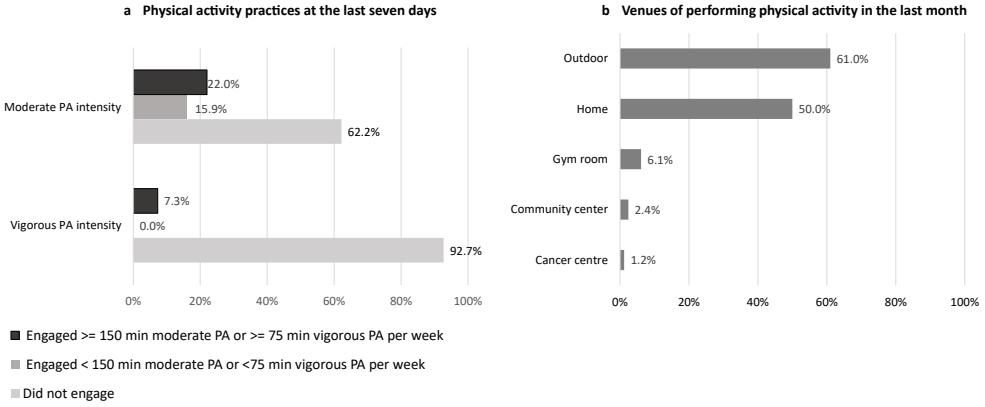

Fig. 3. Physical activity practices after being diagnosed with lung cancer.

crucial role in behavioral interventions by providing repetitive information, which has been shown to effectively promote physical activity in patients with coronary heart disease at little to no cost.[33] Similar findings of using messaging to enhance physical activity were reported in a pilot RCT of using reminder text messages to increase physical activity in colorectal cancer patients,[34] and an RCT of a lifestyle-focused, evidence-based text message support program to motivate patients to be physically active in breast cancer patients.[35]

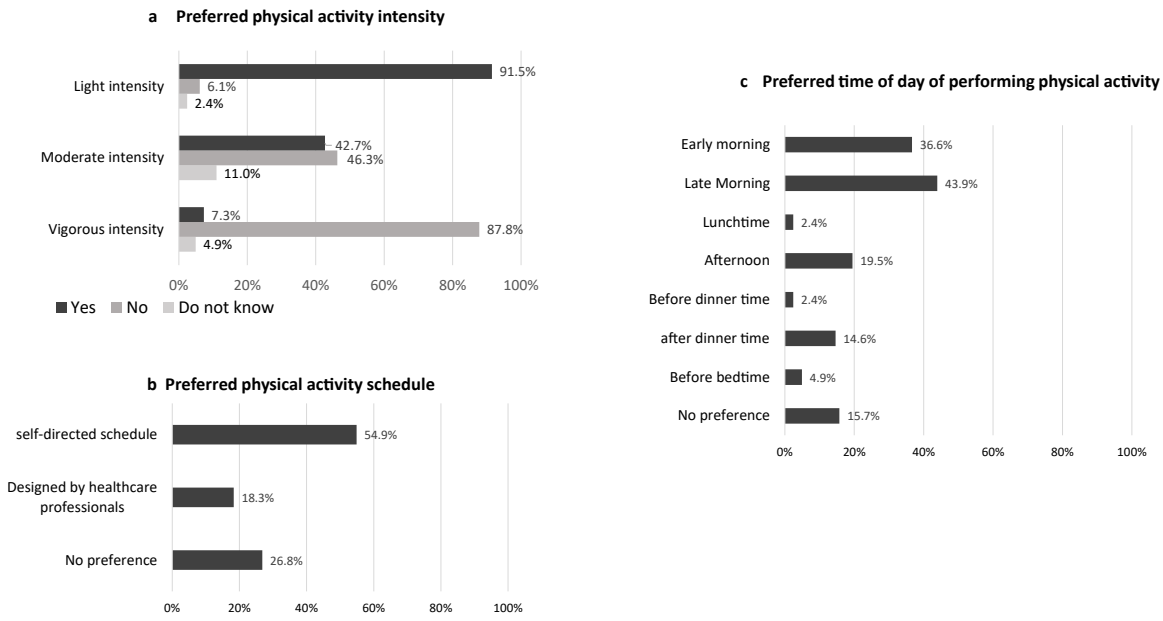

Fig. 4. Preferred physical activity intensity, schedule, and time of day to perform physical activity.

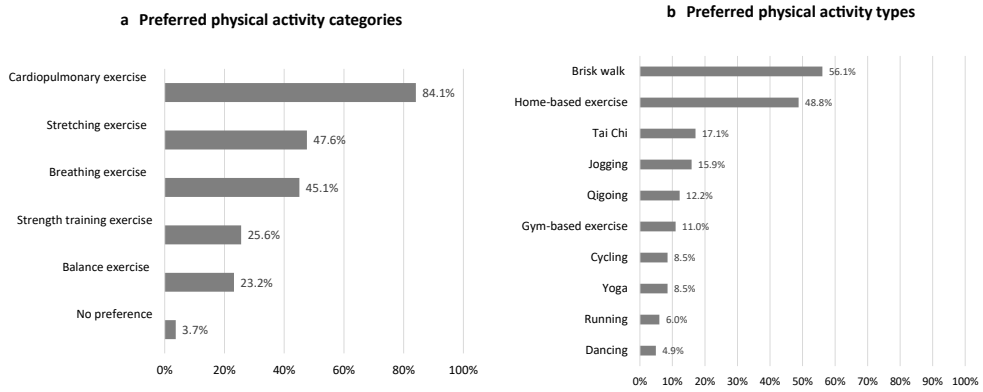

Fig. 5. Preferred physical activity categories and types.

In Hong Kong, smartphone penetration reached 96.3% in 2024.[16] Despite strong evidence supporting mobile text messaging for managing chronic illnesses, existing lung cancer education programs primarily focus on face-to-face sessions for post-discharge rehabilitation and lack continuous, holistic care. Empowering patients to engage in self-management is essential for managing chronic illnesses and promoting physical activity throughout the cancer journey. This study provides a strong foundation for leveraging smartphone-based instant messaging to empower patients in physical activity and disease self-management.

Implications for nursing practice and research

The strength of this study lies in understanding preferences for the physical activity, content, timing and frequency of receiving instant messages. This will help us determine an appropriate schedule for sending messages to ALC patients and aid in designing, developing, and implementing smartphone-based physical activity and self-management support programmes. Our findings can contribute to co-designing a patient-centered, robust, theoretically underpinned smartphone-based exercise program that targets improvements in patients' physical activity, dietary choices and habits, as well as overall health.

The uniqueness and implications of this study focus on three areas. First, this study sheds light on the lack of proactive encouragement by health care professionals in promoting physical activity among ALC patients. Since physical activity plays a critical role in the cancer journey, all health care professionals should understand their roles and be equipped with general knowledge on physical activity to alleviate cancer-related symptoms and treatment. Education for health care professionals can enhance their knowledge, self-efficacy, and motivation to discuss the importance of physical activity in the cancer journey. Clear safety guidelines are essential in helping patients to incorporate physical activity into their routines safely. Second, this study emphasizes tailoring exercise programs to individual preferences and lifestyles, ensuring they are both effective and well-received. The co-design process ensures the development of a smartphone-based exercise program that is evidence-based, practical, and relevant to the target population. To support ALC patients, it is essential to develop tailored, low-impact exercise programs with diverse options catering to individual preferences and capabilities. This approach respects patient autonomy, crucial for maintaining healthy behaviour habits. Third, by leveraging instant messaging systems can provide regular health tips and exercise routines and facilitate two-way communication, allowing patients to ask questions and share feedback. This dynamic platform enhances patient

Table 3
Perceptions on messaging intervention from those who used instant messaging Apps ($N = 64$).

Items	*n* (%)
Instant messaging application used [a]	59 (92.2)
Acceptability of instant messaging intervention [a]	
Feasible to instant messaging to provide cancer-related information and respond to cancer-related inquiries with patients	52 (81.3)
Believed health-related e-messages can remind them to be engaging in physical activity	46 (71.9)
Preferred to receive information about [b]	
Dietary information	55 (85.9)
Cancer and related treatment	45 (70.3)
Physical activity	43 (67.2)
Infection prevention	23 (35.9)
Weight management	21 (32.8)
Emotion management	13 (20.3)
Psychological support	10 (15.6)
Financial management	10 (15.6)
Time of the day to receive health-related e-messages [b]	
Morning	22 (34.4)
Afternoon	37 (57.8)
Evening	17 (26.6)
Night	22 (34.4)
Number of days in a week receiving health-related e-messages	
1–3 days	49 (76.6)
4–5 days	3 (4.7)
6–7 days	12 (18.8)

[a] Responses were made as 'Yes' and 'No'.
[b] Multiple options of choice were allowed.

engagement, provides real-time feedback, and ensures continuous support and adjustments. The combination of tailored interventions, health care professional education, and advanced technology positions this study as a forward-thinking and impactful contribution to cancer care and self-management support.

Limitations

Our study has Characteristics of those advanced lung cancer patients several limitations. First, this study design was a cross-sectional study with no longitudinal follow-up, causal relationships could not be established. Second, we were unable to eliminate potential selection and sampling bias due to the non-probability single-centre sampling method. Our results might not fully represent the broader population. Future studies could aim to recruit a more diverse and representative sample to minimize selection and sampling biases. Stratified sampling techniques could be used in future studies to ensure the inclusion of participants across different demographics, such as age, gender, socioeconomic status, and geographic location. Third, social-desirability bias was a significant issue in questionnaire surveys, which might lead to misleading results. Participants may respond in a way they believe aligns with perceived social norms or expectations, rather than providing their true opinions. Fourth, recall bias is common in self-reported data on physical activity levels, which might lead to over- or under-reporting. To address recall bias, in future studies, we could incorporate objective measures of physical activity, such as accelerometers, pedometers, or wearable fitness trackers (if feasible), rather than relying solely on self-reported data. Fifth, responses to the questionnaire may have been influenced by the individual's personality, self-perception,[36] and may be under- or over-estimated depending on numerous factors when completing the questionnaire. As a result, the findings should be cautiously generalized to other populations and age groups. Sixth, we acknowledge that the data was collected between 2019 and 2020, which might not fully reflect the current patient population. However, the significant gap between participants' positive beliefs about the benefits of physical activity and health care providers' proactive engagement in encouraging their patients to be physically active remains important to report. This finding underscores the need for health care professional training to go beyond technical skills, emphasizing that encouraging ALC patients to stay active should be the shared responsibility of all health care professionals." Lastly, there was no validated lung cancer-specific questionnaire available to assess physical activity preferences. Consequently, we measured preferences on each specific issue using outcome-based questions, without generating a summative score. Findings from Cordasco et al. suggest that presenting health information using single-item health literacy screeners may be an effective approach for individuals regardless of their health literacy levels.[37]

Conclusions

This is the first article to specifically investigate ALC patients' knowledge of the benefits of physical activity, their physical activity habits, and the acceptability of a messaging intervention. It addresses significant health knowledge and behaviour gaps, highlights the need to empower physical activity self-efficacy, and emphasizes the importance of tailored health education and physical activity programs. In clinical practice, health professionals should advocate for their ALC patients to reduce sedentary behaviour and promote physical activity throughout the cancer journey. Health care professionals should provide physical activity guidance in routine care to encourage patients to be physically active, which could promote ALC patients' physical and mental well-being. Tailored interventions that consider the unique challenges faced by ALC patients are essential to ensure that physical activity recommendations are both feasible and effective. In research, future studies should explore innovative approaches to delivering health information and promoting physical activity adherence. Smartphone-based messaging interventions might offer promising solutions for providing personalized health education, encouraging physical activity, and improving health outcomes for ALC patients.

CRediT authorship contribution statement

Agnes Yuen-Kwan Lai: Conceptualization, Methodology, Statistical analysis, Writing – Original. **Asa Choi:** Conceptualization, Methodology, Writing - Review & Editing. **Denise Yee-Shan Yiu**: Conceptualization, Methodology, Data collection. **Yuying Sun**: Writing - Review & Editing. **Tyrone Tai-On Kwok**: Writing - Review & Editing. Wing-Fai Yeung: Review & Editing. **David Chi-Leung Lam:** Writing - Review & Editing. **Tai-hing Lam**: Writing - Review & Editing. All authors have read and approved the final manuscript.

Ethics statement

The Institutional Review Board (IRB) of The University of Hong Kong/Hospital Authority Hong Kong West Cluster (HKW) approved the research protocol (HKW IRB No. UW 19–597). The study was also registered with the National Institutes of Health (Identifier: NCT04104516). This study was conducted in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. All participants provided written informed consent.

Data availability statement

The data that support the findings of this study are available from the corresponding author, AYKL, upon reasonable request.

Declaration of generative AI and AI-assisted technologies in the writing process

No AI tools/services were used during the preparation of this work.

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Declaration of competing interest

The authors declare no conflict of interest.

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