Use of Measurement Tools to Validate the Health Effects of Forest Healing Programs: A Qualitative Analysis

Hae-young Chun 1, Inhyung Cho 1, Yoon Young Choi 1, Sujin Park 2, Geonwoo Kim 2 and Sung-il Cho 1,*

1 Graduate School of Public Health, Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Republic of Korea; maminihae@gmail.com (H.-r.C.); ihcho04@snu.ac.kr (I.C.); young.feb17@snu.ac.kr (Y.Y.C.)
2 National Institute of Forest Science (NIFoS), 57, Hoejgi-ro, Dongdaemun-gu, Seoul 02455, Republic of Korea; snowshoe@korea.kr (S.P.); bkim5020@korea.kr (G.K.)
* Correspondence: persontime@hotmail.com

Abstract: Research is increasingly focusing on the health-promoting effects of forest healing programs. A number of different health indicators are in use, necessitating the establishment of standardized health measurement tools and protocols for forest healing. Also, it is necessary to improve the indicators and protocols by incorporating the opinions of program participants and instructors, so we conducted a qualitative analysis based on focus group interviews (FGIs) and in-depth interviews (IDIs). We collected opinions through interviews conducted for about 1 h with 32 participants in the pilot study and three instructors of the forest healing program. We utilized the MAXQDA program, commonly employed for qualitative research, such as coding and analyzing interview transcripts and literature reviews, as part of the qualitative research process. Three researchers coded and categorized the data, and the first author and corresponding author performed the final coding and categorization. Opinions on the five mental health questionnaires, three physical health measures, and exercise behavior measures used in the forest healing program were solicited. Opinions on the measurement protocol were also solicited. Participants faced challenges in completing the mental health questionnaire due to inappropriate terminology, difficulty in providing truthful responses due to repetitive questions, and the complexity of answering exercise-type questions due to the length of the survey and the absence of clear examples. It was identified that improvements are needed in the future. Some participants commented on the need to measure blood circulation and short-term health changes, and others noted that performing measurements in large groups was difficult, such that there was a need to introduce a measurement protocol for groups. This study is the first to qualitatively evaluate the validity of health measurement tools associated with forest therapy programs. It can contribute to the establishment of standardized health indicators and protocols, as well as serve as a valuable reference for selecting measurement tools to evaluate the effectiveness of forest healing interventions.

Keywords: shinrin-yoku; forest bathing; focus group discussion

1. Introduction

Forest therapy evolved from forest bathing (shinrin-yoku); this term was introduced in Japan in 1982 and translates as enjoying the comfort of the forest. Forest therapy developed from research into psychological and physiological changes occurring in a forest environment [1]. In South Korea, it is defined as “activities to strengthen the human body’s immunity and promote health by utilizing various elements of nature, such as scents and scenery” [2]. Forest therapy theory is associated with Attention Restoration Theory (ART) [3], Stress Recovery Theory (SRT) [4], Prospect-Refuge Theory [5], and the Dose of nature theory [6]. ART suggests that the forest environment promotes tranquility and revives interest in oneself. SRT emphasizes the healing aspects of the forest
Research aiming to verify the health-promoting effects of forest healing programs is underway worldwide [7]. Systematic literature reviews [1,7] have shown that a variety of health indicators are used in forest healing research, including ones related to cardiovascular health, the immune system, and the neuroendocrine system. In addition to physiological effects, effects on the emotional state and mental health have also been reported.

Spending time in a forest has marked effects on blood pressure (BP), pulse rate, and sympathetic nerve activity [8–13] and reportedly significantly increased positive emotions and decreased negative emotions [13–15].

The parameters typically used to evaluate the physical health effects of forest healing are systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate variability (HRV), and blood sugar [1,7]. Prior research on psychosocial effects used the Profile of Mood States (POMS), Positive Affect and Negative Affect Schedule (PANAS), and State-Trait Anxiety Inventory (STAI) [7]. Other surveys have used questionnaires on quality of life (QOL) [16–18], stress [19–21], and depression [22–24].

Few studies described their rationale for the use of a particular tool, but in those that did, the most frequent reason was its validity and reliability [25,26] or because it had been used in prior studies [24,25,27]. In other words, tools were used on the basis of their general utility rather than their specific applicability to forest healing.

Forest healing programs ask subjects to directly report their health and Quality of Life (QOL), ensuring that their experiences are conveyed free from interpretation by others; what is considered important outcomes by investigators may diverge from those that subjects deem significant [28]. Expectations regarding health effects can influence results, particularly concerning psychological indicators. Accounting for the limitations of subjective responses is important because outcomes can vary based on the subject’s attitude to the test or expectations thereof [29]. To reduce error, we evaluated the utility of measures from the perspectives of both participants and facilitators. The health measurement tools used to verify the effects on the health of forest healing programs can be applied to healthy individuals, elderly persons, and patients with chronic diseases. There is a need for concise and dependable instruments to promote program participation, particularly by older individuals, those with health challenges, and marginalized minority groups, who are often underrepresented [30].

The fact that forest healing programs and exposure to green environments promote physical and mental health has been well-established through previous research [7]. However, many commonly used health indicators to confirm such health benefits are known for their non-invasiveness and ease of use in a forest setting without the need for medical professionals [7,31]. Nevertheless, it is essential to investigate whether participants who directly assess their health status through these health indicators find them easy to use and if there are any limitations. Additionally, we explored whether forest therapy program instructors who operate forest healing programs and evaluate the health promotion effects encounter any difficulties in using these assessment tools.

Understanding the long-term health promotion effects and mechanisms of forest healing programs is crucial for the successful implementation of nature prescriptions in preventing and managing the increasing prevalence of chronic diseases [32]. To achieve this, the selection of standardized indicators is necessary, and it is important to determine whether commonly used health indicators are suitable for on-site use.

Various tools were investigated to validate the health effects of forest healing programs. Rather than comparing scores before and after the program, we solicited the opinions of participants and instructors. We conducted a qualitative analysis using focus group interview (FGI) and in-depth interview (IDI) methods to assess the appropriateness of various health measurement tools for assessing the health effects of forest healing programs. The aim was to accurately evaluate their utility in forest healing programs.
Additionally, we incorporated participant feedback to enhance the effectiveness of the health measurement tools.

2. Materials and Methods

2.1. Pilot Study

A total of 99 participants stayed in the Yeongju National Center for Forest Therapy for 2 or 3 days and participated in a program that included walking on trails for an average of 1 h/day, listening to bird songs, smelling and hugging trees, and admiring the scenery. At each of the 15 affiliated organizations of the Korea Forest Welfare Institute, where forest therapy programs are conducted, there is at least one forest therapy guide. The program participation capacity at the affiliated organization of the Korea Forest Welfare Institute is set at 10–15 participants per session, and each forest therapy program instructor is required to conduct at least one program per week. With an assumption of 10 participants per guide, one program per week, and a research period of 12 weeks for each institution, a total of 120 participants are expected to visit. Using a sample size calculator with a confidence level of 95% and a margin of error of 5%, the calculated sample size is 92. To account for potential dropouts, the target number of participants was set at over 92, and a total of 99 participants were recruited.

Singing bowl meditation was also scheduled. Before and after the program, HRV, SBP, and DBP were measured, and a self-reported health survey was conducted (Institutional Review Board no. 2202/003-014).

2.2. Pilot Study Data Collection Protocol

After obtaining consent, the participants in the forest therapy program were divided into small groups. Pre- and post-program online self-report questionnaires were completed, and Heart Rate Variability (HRV), Systolic Blood Pressure (SBP), and Diastolic Blood Pressure (DBP) were measured twice. We used the EASY X800 digital machine (SELVAS Healthcare, Inc., Seoul, Republic of Korea) to measure blood pressure and the SA6000 machine (MEDICORE Co., Hanam-si, Republic of Korea) to measure heart rate variability. Participants with smartwatches were required to wear them throughout the program, and data were extracted after completion thereof. “In-body” measurements were conducted to assess health status at baseline. We used InBody 970 (InBody Co., Seoul, Republic of Korea) for body composition measurements.

2.3. In-Depth and Focus Group Interviews

2.3.1. Participants

Participants were recruited voluntarily by means of advertisements posted on a website (online) and at the Forest Healing Center (offline). We obtained consent from the participants for the use of their health data for research purposes, and appropriate compensation was provided. Data were collected from the 99 participants in the pilot study during 1-h interviews by teams of up to five individuals using the FGI or IDI method. To align with the study objectives, the interviews used open-ended questions to inquire about the suitability of the health measurement tools used before and after the forest therapy program (Supplementary Table S1). In total, 32 individuals participated in the forest therapy program from June to July 2022 (Table 1), and 3 forest therapy instructors (Table 2) provided health measurements before and after the program.
Table 1. Demographic characteristics of the participants and instructors.

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Participants</th>
<th>Instructors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td>Male</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female</td>
<td>23</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>20s</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30s</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40s</td>
<td>9</td>
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<td></td>
<td></td>
<td>50s</td>
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<td></td>
<td></td>
<td>60s</td>
<td>2</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td>Gyeonggi</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gyeongbuk</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Daegu</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Daejeon</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Busan</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seoul</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chungnam</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chungbuk</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2. Opinions of participants and instructors on the feasibility of health measurement tools.

<table>
<thead>
<tr>
<th>Category</th>
<th>Subcategory</th>
<th>Opinions Common to Participants and Forest Therapy Program Instructors</th>
<th>Participants’ Opinions Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>All measurement tools</td>
<td>Opinions about the measurement environment and tools</td>
<td>Difficulty/ease of measurement</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Opinions on adding/excluding measurement tools</td>
<td>Opinions on adding/excluding measurement tools</td>
<td>NA</td>
</tr>
<tr>
<td>Body measurements</td>
<td>In-body</td>
<td>Doubts about health-improving effects</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Blood pressure</td>
<td>Expectations of health improvement/interpretation of health results</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Heart rate variability</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Surveys</td>
<td>Mental health assessment tools and exercise behavior surveys</td>
<td>Doubts about health-improving effects</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self-assessed health status and perceived health-improving effects</td>
<td>NA</td>
</tr>
<tr>
<td>Smartwatch</td>
<td></td>
<td>Time-consuming</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Difficulty of exporting data</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Challenges with continuous wear</td>
<td>NA</td>
</tr>
</tbody>
</table>

NA, not applicable.

2.3.2. Interviews

The interviews were conducted online via Zoom because of the social distancing measures necessitated by the coronavirus disease 2019 (COVID-19) pandemic. Groups were divided, and Zoom meetings were conducted between April and June 2022. An introductory interview was followed by a detailed interview, in which participants were asked about the field applicability of the survey tools and measurement protocols before and after the forest healing program. With the consent of the participants, the interviews were recorded and transcribed for qualitative analysis.

2.3.3. Measurement Tools

We systematically reviewed the literature on the measurement of physical and mental health and formulated a research protocol [7]. We selected five mental health questionnaires that met the following criteria: few questions, completion within 10 min, written in Korean, and appropriate for administration before or after 1-day or 1-night stays. To
measure physical health, we used the equipment of the Forest Therapy Center. Six experts in mental health, healthcare, and forestry were consulted during the planning of this study.

A survey was conducted regarding the usability of the five mental health measurement tools. Anxiety was assessed by the State-Trait Anxiety Inventory (STAI), depression by the Beck Depression Inventory (BDI), mood using the Profile of Mood States-Brief (POMS-B), QOL by the Euro-Quality of Life-5 Dimension (EQ5D), and static and dynamic emotions using the PANAS. Four physical health indices (DBP, SBP, HRV, and in-body) and one physical activity index (Global Physical Activity Questionnaire [GPAQ]) were used. The GPAQ is used to analyze the daily and weekly frequencies of high- and moderate-intensity exercises. Additionally, opinions regarding the feasibility of the protocols and health measures were solicited.

2.4. Analysis

Qualitative analysis was conducted using MAXQDA 2022 software. After data coding and categorization by three researchers (H.-r.C., I.C., Y.Y.C.), the first author (H.-r.C.) finalized the codes. The FGIs were recorded and transcribed by a professional transcriber, and based on the transcripts, the participants’ verbatim comments were transcribed into Excel and subjected to qualitative analysis using MAXQDA software.

The first author (H.-r.C.) repeatedly read the transcribed content and identified topics and subtopics, which were subjected to descriptive thematic analysis by two authors (I.C., Y.Y.C.). Relevant text fragments were also identified [33].

The second author (I.C.) classified themes and subthemes according to a final coding taxonomy. The two authors (H.-r.C., I.C.) reviewed the final coding taxonomy and organized the information [33]. Finally, the corresponding author reviewed and finalized the tables [33]. The four researchers involved in this study regularly exchanged feedback and discussed the interview data (peer debriefing) [34].

Validating findings means that the researcher determines the accuracy or credibility of the findings through strategies such as Member checking and Triangulation [35]. Several qualitative researchers have addressed this idea [36,37]. Qualitative inquirers triangulate among different data sources to enhance the accuracy of a study. Triangulation is the process of corroborating evidence from different individuals, types of data, or methods of data collection in descriptions and themes in qualitative research [35]. To review various data sources, we targeted not only participants in the forest healing program but also forest healing instructors who operate the program, and we used both individual interviews (IDI) and focus group interviews (FGI) simultaneously. Researchers also check their findings with participants in the study to determine if their findings are accurate. Member checking is a process in which the researcher asks one or more participants in the study to check the accuracy of the account [35]. Additionally, three researchers conducted the analysis collectively, conducted weekly reviews and carried out Member checking, including reviews by the corresponding author.

3. Results

3.1. General Characteristics of the Participants and Instructors

Table 1 lists the general characteristics of the participants. As stated above, there were 32 participants and three instructors in the study. There were more female than male participants and instructors (n = 23 and 2, respectively). Regarding age, one of the instructors was in their 20s, and two were in their 30s; most of the participants were in their 40s and 50s (n = 9 each). The participants were most likely to reside in the Gyeongsangbuk-do region (n = 18).
3.2. Opinions on the Measurement Tools and Environment

Table 2 lists the opinions of the participants and instructors on the mental health, physical health, and smartwatch tools used for health measurements before and after the program. Participants generally had positive opinions of the measurement environments of all the measurement tools.

Table 2 presents the main opinions from Supplementary Table S2. We have provided the frequency of opinion keywords for each category in Supplementary Table S2. The opinions about the measurement environment and tools for all measurement tools were 66. For body measurement tools opinion, the difficulty/ease of measurement was 81. Keywords related to doubts/expectations about health-improving effects for blood pressure were 16, for Inbody were 36, and for HRV were 72. For the survey, the difficulty/ease of measurement was 316, with 103 related to content, 15 related to the difficulty/ease of measurement method, 34 related to measurement time, 1 related to responsiveness, 59 related to the Exercise Behavior Questionnaire, 54 related to the measurement environment, and 50 opinions related to the difficulty in interpreting terminology. Opinions about doubts/expectations about the health-improving effects of the questionnaire were 66. Opinions about the difficulty of measurement for smartwatches were 25.

In Table 3, opinions regarding all measurement tool environments, body measurement tools, surveys, and smartwatches for each participant and the forest healing instructor are summarized.

Table 3. Opinions on all measurement tool environments, body measurement tools, surveys, and smartwatches.

<table>
<thead>
<tr>
<th>3.2. Opinions on the measurement tools and environment</th>
<th>3.3. Body measurement tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>The place to fill it out was quiet, comfortable, and good. (Participant A)</td>
<td>3.3.1. Health improvement: in-body</td>
</tr>
<tr>
<td>I think the place to inspect was a bit small. (Participant B)</td>
<td>Why do we need to measure our body in such detail, such as fat and muscle mass. (Participant C)</td>
</tr>
<tr>
<td>3.3.2. Blood pressure and Heart Rate Variability</td>
<td>There were some people who were reluctant to participate in the in-body experience, so I convinced them to participate by saying that they could only see it on that day, but there were also some who refused to participate, saying that they really didn’t want to do it, that they didn’t want to show their body to anyone. (Forest healing instructor A)</td>
</tr>
<tr>
<td>I don’t think the program actually has a direct health benefit, i.e., lowering blood pressure. (Participant D)</td>
<td>3.3.3. Suggested physical health measurement tools</td>
</tr>
<tr>
<td>My blood pressure goes up when I’m stressed, so I thought it was related to that. (Participant E)</td>
<td>I think it would be good to do something like electroencephalography (EEG), and I wonder if you can control how stable the waves are and things like that. (Participant G)</td>
</tr>
<tr>
<td>As for the stress test (HRV), I think I expected a little change because I participated in the program at the recreational forest (Participant F)</td>
<td>I wonder if there is something that can be measured that can show the change a little more quickly, so that the users can know that it was good, for example the change in body temperature or circulation, so I think it would be good to have an experiment that can show that a little more quickly. (Participant H)</td>
</tr>
<tr>
<td>3.3.4. Physical health measurement instrument protocols</td>
<td>Yes, it was okay, and they explained it before measuring anyway, and there was no difficulty when doing it...and the next day, if I went on time, it was measured just in time, so I think there were no complaints or difficulties in that respect. (Participant I)</td>
</tr>
<tr>
<td>I don’t think I had any difficulties because it was a familiar machine. (Participant J)</td>
<td></td>
</tr>
</tbody>
</table>
3.4. Survey

3.4.1. Perceived mental health effects

When I did the post-survey, I felt a little bit like, ‘Oh, she’s stabilized, she’s more sta-ble.’ I think the intention is good, but I don’t think it can be changed overnight, so first, I think the program period was a little short, and it would have been better to make it a little longer to do that. (Participant K)

Honestly, it didn’t change much because I checked it in 1 day, so I think I was thinking that a measurement tool would be helpful. (Participant L)

If there is something that you want to measure, I think it would be much more effec-tive to make a more detailed and delicate questionnaire to measure it. (Participant M)

3.4.2. Inappropriateness of questionnaire terms

Terms are not commonly used in daily life

In addition, some items in the mental health questionnaire were not relevant to eve-ryday life due to uncommon adjectives (e.g., ‘agile’, ‘strong’), and some participants were uncomfortable answer-ing questions about their sexuality. (Forest healing instructor B)

Terms not appropriate for healthy individuals

There were also survey items that were more appropriate for people with severe mental health dis-orders, and some participants felt that these items were not appro-priate for most forest therapy program participants.

There are also questions for people who are seriously ill. Shouldn’t you go to a hos-pital in such cases? Yes. (Participant N)

Terms that do not seem to con-sider privacy

One of the questions was ‘How is your sex drive these days?’, which was the most em-barrassing question, and I giggled every time it came up. (Participant O)

Difficulty un-derstanding terms in the GPAQ exercise

When the participants answered the GPAQ, I realized that the exercises I do are not all listed in the examples here, and some of them said that the exercise I am doing now is medium intensity or high intensity … I feel a little bit like there might be some ambiguity in the answers. (Forest healing instructor B)

It’s jogging, but I tend to walk a little fast, so I had a thought that it might be medium intensity, a little bit like this, so I think that’s how I defined it. (Forest healing instructor B)

Questionnaire format

The process of filling out the questionnaire was fine, and we were comfortable and happy to fill out the online questionnaire, but there are some people who can’t do it (Participant P)

Because the smartphone is small, you can’t zoom in and the questions don’t continue, and older people have to look at it twice or three times … Yes, so I would rather have to tap or something, but some were a little uncomfortable with the cell phone. The younger ones were fine, but the older ones were all uncomfortable. (Forest healing instructor C)

Questionnaire length

I thought the length of the questionnaire was appropriate. (Participant Q)

I have so many questions. (Forest healing instructor B)

3.5. Smartwatch

Data export

I finished it quickly thanks to the guide and the teacher who explained it to me, but I thought it might be a little difficult for people who are a little older or not familiar with machines. (Participant R)

No, honestly, it was easy to export. (Participant S)

I downloaded the Apple app and checked it, and the data transmission was fine, so I didn’t have much trouble in the field. (Forest healing instructor B)

But now, it takes too much time to transfer data, so I think it would be better to use a charging line to transfer data to save time. (Forest healing instructor B)

Continuous wear

I have to wear my smartwatch all the time, but if I take it off for charging or sleeping, I don’t think I can collect data. (Participant T)

However, regarding the physical measurement tools, there was an opinion that a more comfortable measurement environment could be achieved by increasing spacing be-tween the machines.
3.3. Body Measurement Tools

3.3.1. Health Improvement: In-Body

The in-body measurement was not intended to assess improvement but to identify basic characteristics before the program. However, some participants questioned the need for this measurement.

3.3.2. Blood Pressure and Heart Rate Variability

There were a variety of opinions about BP, with some participants saying that significant changes could be seen within 2 days and others that no significant change was evident. Nevertheless, some participants expected significant changes in DBP, SBP, and HRV, and several stated that there was a need for interpretation of health outcomes.

3.3.3. Suggested Physical Health Measurement Tools

Because the forest healing program lasts about 2 days, several participants suggested assessment of short-term health-promoting effects, such as increased body temperature, improved blood circulation, pain relief, and brain-wave analysis.

3.3.4. Physical Health Measurement Instrument Protocols

Participants responded that, for the most part, the machine was familiar to them, and there were no difficulties because there was sufficient explanation before the measurements.

3.4. Survey

3.4.1. Perceived Mental Health Effects

Regarding the questionnaires, some participants had doubts about whether improvements in health would manifest within 2 days. However, participants subjectively reported experiencing stress relief and improved mood.

3.4.2. Inappropriateness of Questionnaire Terms

Terms are not commonly used in daily life

Table 4 shows the frequencies of questionnaire items considered difficult to understand, which was a common opinion among both participants and instructors. Agile, strong, and insignificant were described as difficult to understand seven, four, and four times, respectively. Supplementary Table 1 presents both Korean and English words.

<table>
<thead>
<tr>
<th>Word</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agile</td>
<td>7</td>
</tr>
<tr>
<td>strong</td>
<td>4</td>
</tr>
<tr>
<td>insignificant</td>
<td>4</td>
</tr>
<tr>
<td>exhausted</td>
<td>2</td>
</tr>
<tr>
<td>tense</td>
<td>2</td>
</tr>
<tr>
<td>discouraged</td>
<td>2</td>
</tr>
<tr>
<td>annoyed</td>
<td>2</td>
</tr>
<tr>
<td>I don’t feel particularly guilty</td>
<td>1</td>
</tr>
<tr>
<td>I am efficient</td>
<td>1</td>
</tr>
<tr>
<td>I am flustered and at a loss for words</td>
<td>1</td>
</tr>
<tr>
<td>lively</td>
<td>1</td>
</tr>
<tr>
<td>I am a failure</td>
<td>1</td>
</tr>
<tr>
<td>energetic</td>
<td>1</td>
</tr>
</tbody>
</table>
Terms not appropriate for healthy individuals

Most of the people who attend the forest therapy program are those who can walk, so some participants found certain questions inappropriate as they were designed for individuals with serious illnesses.

Terms that do not seem to consider privacy

Some participants felt embarrassed and wondered if it was necessary to include the question about recent sexual desire.

Difficulty understanding terms in the GPAQ exercise behavior survey

There was feedback that the examples of exercise types provided in the GPAQ were ambiguous.

Questionnaire format

The majority of respondents found online questionnaire completion not at all difficult, but there were occasional instances where older individuals found it challenging.

Questionnaire length

Some participants responded that the questionnaire was lengthy, but there were more individuals who found it appropriate.

3.5. Smartwatch Results

Data export

Several responses described the ease of exporting data from smartwatches, but doing so took a considerable amount of time, and errors often occurred for some devices.

Continuous wear

Many participants expressed difficulty and discomfort with consistently wearing a smartwatch.

4. Discussion

We examined whether health measurement tools used in forest healing programs were appropriate for field application. The participants were satisfied with the locations of the physical measurements and completed the questionnaires without any marked difficulties.

Many participants had questions about in-body, BP, and questionnaires for assessing the health-promoting effect of forest healing, but improvement of HRV was widely expected to enhance health. It was suggested that a tool that can evaluate short-term changes in health, such as over 1 or 2 nights, should be used. Many participants found the terminology of the questionnaires difficult to understand or regarded it unsuitable for assessing forest healing. The participants complained about the time required to export data from smartwatches, the errors that occurred, and the need to charge the watches, which hampered continuous wear.

Many participants had doubts about whether the short-term health-improving effects of the forest healing program could be examined using previously employed physical health measurement tools. In-body has been used for before-and-after comparisons; in this study, it was used to assess baseline characteristics. Some participants expected an improvement in their Blood Pressure, but others did not. Two previous studies [1,7] reported the health-promoting effects of forest therapy programs. Because it can be measured simply and quickly and has a considerable impact on health, BP is suitable for verifying the health-promoting effect of forest healing, HRV is a marker of stress, and
participants in the forest healing program reported reduced stress. The improvements of the HRV normal-to-normal interval (SDNN) standard deviation [23], high-frequency (HF)/low frequency (LF) ratio, heart rate [10,38], mean heart rate, SDNN, and root mean square of successive differences (RMSSD) were significant [39].

There was doubt about the health-promoting effects of the questionnaires, and several participants reported difficulties with their contents or felt that they were unsuitable for forestry programs. The PANAS was described as comprising many difficult-to-understand terms rarely used in daily life, and the high- and moderate-intensity exercise examples in the GPAQ tool were described as difficult to understand. Some participants stated that the questions in the EQ5D were not appropriate for ambulatory individuals, i.e., participants in the forest healing program, but were appropriate for patients with diseases.

Prior studies have examined the health-promoting effects of the questionnaires used herein in forestry sites. Significant changes were detected in the PANAS score after forest healing programs [40,41]. However, because the subjects must understand the survey instruments, their level of education should be considered. The EQ5D score showed significant changes in some studies but not in others [16,18]. In studies using other QOL indices, total QOL scores significantly improved [42,43]. Therefore, it is necessary to evaluate other tools that measure QOL and develop means of evaluating the effects of forest healing programs thereon.

GPAQ is a universal physical activity measurement tool used in national health surveys such as the National Health and Nutrition Examination Survey. It is important that the subject understands the questionnaire because the correlation coefficients between questionnaire-based and direct measurements of physical activity vary widely, from −0.71 to 0.96 [44]. Therefore, the GPAQ questionnaire should cover a more diverse range of exercises. Previous studies have shown that walking or physical activity in natural environments increases physical, social, and psychological health [45]. Additionally, physical activity in green spaces encourages positive behaviors [46], and the experience of forest healing programs promotes long-term physical activity and enhances the forest experience. Therefore, while the continued use of the GPAQ as a physical activity measurement tool is necessary, there may be a need for more specific examples of exercise types in the questionnaire.

Our participants complained about the time needed to export data, errors, and the difficulty of continuously wearing smartwatches due to the need for charging. In a systematic review of studies using smartwatches [47], there were limitations related to battery power, data quality, and the need for continuous wear. Other limitations included the lack of standard data collection and processing procedures; technical factors such as device type, firmware version, and sampling rate; and biobehavioral variables such as body mass index and wrist circumference [48].

Few studies have evaluated the effectiveness of forest healing using wearable sensors [49,50], although, in one study, wearable sensors were reported to be suitable for verifying the effect of forest healing [51]. Exposure to nature reportedly affects heart rate [49,50,52], so assessment of heart rate using wearable devices will enable rapid evaluation of the effect of forest healing. We evaluated the feasibility of field research using smartwatches, which appear suitable for research at forest sites, provided appropriate precautions are taken.

We evaluated the suitability of physical health measurement tools, issues related to questionnaire interpretability, access to the forest site, and the appropriateness of the questions. For example, some QOL-related questions were more appropriate for individuals with difficulty walking, as pointed out by the participants. In addition, for long-term measurement of the health effect of forest healing, it is necessary to assess the participant’s experience with the measurement tools and solicit their opinions on their appropriateness. For example, the level of difficulty of smartphone or smartwatch use and of completing physical health measurement tools not familiar to the participants could be overlooked by a researcher. We aimed to identify such issues to aid future research.
A variety of health indicators have been used in studies of forest healing. This is the first study of the field applicability of health measurement tools and protocols related to forest healing. The findings will enable assessment of the health-promoting effects of other forest healing programs. We believe that these research findings can be utilized to determine the priorities of indicators used in future forest therapy settings. For example, focusing on depression, mood, and anxiety could be prioritized, while the Quality of Life (QOL), which has been widely used for improving the overall quality of life through participation in forest therapy programs, may be considered a lower priority.

To select standardized health measurement indicators for forest healing programs, it is important to identify new indicators and examine the appropriateness of those already in use. We believe that the qualitative analysis tools used in this study can serve as a reference for future studies of forest healing programs. We conducted interviews with individuals who volunteered for the program, and the results could be generalized to other forest healing sites. This study can be considered representative because it was conducted at Yeongju Forest Healing Center, which is the largest in South Korea. Qualitative research requires little or no prior research or knowledge of the phenomenon or locale under study. The tools and protocols typically used in forest healing programs should be understood from the perspective of both the participants and their instructors. Qualitative research based on interviews provides an opportunity to obtain rich data from the direct statements of participants [53].

This study believes that if the health assessment indicators evaluated in this research are applied to the field of implementing forest healing programs, long-term health evaluations can be conducted. This, in turn, is expected to contribute to elucidating the health-promoting effects of forest healing programs. Furthermore, it is thought that this could serve as supporting evidence for the introduction of nature prescription programs, where healthcare professionals recommend spending time outdoors as a written prescription for patients [54]. These nature prescription programs aim to alleviate the high burden of chronic diseases and increase physical activity in natural environments [54].

We collected several types of data, enabling us to consider multiple perspectives. In addition to one-on-one IDIs, we analyzed interviews with forest healing instructors and participants in a pilot study. The validity of the study arises from the use of stimulated recall during the interview process [55,56]. There were two main reasons for this: first, the interviews were conducted as soon as possible after participation in the forest healing program to promote accurate recall, and second, the interviews were conducted during the COVID-19 pandemic and took place in a comfortable environment. We implemented these measures to increase the reliability and validity of the data.

This study was qualitative research that sought opinions using only the existing tools. However, in the future, there may be a need to introduce new tools and gather opinions on the improved tools. In future research, there is a need for validation work to address the limitations identified in the health measurement tools used in this study. Subsequently, with the validated tools, there will be a requirement for long-term health promotion assessments and the elucidation of health-promoting effects using various health indicators. Additionally, considering the benefits of utilizing smartphones and wearable sensors to track compliance in nature prescription research [57], it is suggested that the development of a forest healing program app or research involving the simultaneous use of apps with smartwatches and wearable devices could facilitate the smooth utilization of these tools.

5. Conclusions

This study is the first qualitative research conducted through FGI and IDI to investigate the appropriateness of health measurement tools used in forest healing programs for field application. The results indicate that the tools used can be suitable in a forest environment, but there were simultaneous doubts and expectations regarding whether these tools would impact health promotion. Additionally, there were opinions pointing out the
difficulty in interpreting survey terminology, and the introduction of tools capable of assessing short-term effects was recommended. The results will facilitate the establishment of standardized health indicators and protocols for forest therapy programs. Subsequent research should focus on tools capable of detecting rapid changes in health following short-term interventions. Additionally, it is essential to use terminology and survey instruments that are understandable by participants. There is a need to design questionnaires to assess the effectiveness of forest therapy. Additionally, unnecessary questions should be identified using item response theory. Assessment of long-term health changes could contribute to the development of medically oriented forest therapy programs. Our findings will serve as a valuable reference for selecting measurement tools to evaluate the effectiveness of forest healing interventions.

**Supplementary Materials:** The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/f14122405/s1, Table S1: The frequency of difficult-to-understand terms including Korean words.

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