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# D9.132 - Review of applications for citizen health and welfare assessment

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## Abstract

In recent years, quality of life of residents, eating habits, stress, daily health status, and need for amelioration of physical symptoms in radiation protection measures such as long-term evacuation after a nuclear accident and return to the evacuation area have been identified as key issues that need to be addressed in case of a nuclear accident. Meanwhile, advances in communication technology have progressed across the world, portable devices have become widely used, and applications using mobile devices are becoming widespread. The principal aim of the present study is to review existing mobile applications - and propose guidelines for novel tools if necessary - to enhance citizen participation in data collection on health and well-being indicators in the aftermath of a nuclear accident. In order to review existing applications and tools for monitoring health and well-being (Task 3.1), we decided to explore the mobile applications and devices relevant to the aims of WP3. The present report summarizes health applications being utilized in Fukushima as part of the residents' support activities after the Fukushima Daiichi nuclear power plant accident; proposes how to mitigate the physical and psychological effects related to radiation measurements; and summarizes the content of the guidelines for stakeholders. Furthermore, as a concept of investigation on long-term health and well-being after a nuclear accident, we compiled a report on the application tools expected based on the basic concepts of health and well-being applications. In order for stakeholders to provide assistance so that residents can acquire the awareness of coexisting with radiation in their lives, in the event of a nuclear accident, it is important to combine tools commonly used among residents while utilizing information on research activities that are being implemented globally as mobile applications.

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## 1. Background and Purpose

A wide variety of questionnaires exist about quality of life, diet, stress, daily health status, and physical symptoms. These questionnaires are widely used as applications via mobile devices [1, 2]. In fact, applications have become established among residents as integrated types incorporating survey tools on health and well-being.

In nuclear accidents to date, residents have been affected not only by direct radiation exposure, but also by long-term radiation protection measures such as evacuation and indoor evacuation, which have negative psychological effects [3, 4]. When dealing with long-term radiation protection measures, it is important to assess the residents' quality of life, dietary habits, stress, daily health status, physical symptoms, in order to improve them.

In recent years, communication technologies have considerably progressed, and portable devices and their applications have become widely used. By the end of 2014, the number of mobile phone subscribers in the world reached approximately 7 billion, which means a penetration rate of 96% of the global population [5]. The principal aims of the present study were to administer a survey on residents' health and well-being by using a mobile application, and further link the results to efforts to improve residents' quality of life as part of long-term radiation protection countermeasures at the time of a nuclear accident.

## 2. Task 3.1 Review of existing Applications and Tools for Health and Well-being Surveys

Currently, there is a great number of mobile applications and tools for performing surveys on health and well-being of the general population. However, in the case of long-term radiation protection measures after a nuclear accident, there is insufficient knowledge regarding the use of existing applications and tools of survey on health and well-being. In addition, by identifying the concepts on health and well-being considered to be global standards, we would like to develop the concept or guidelines for applications and tools of mobile devices that conform to the aims of the present study.

### 3.1. Resident Support Activities and Applications in the Fukushima Daiichi Nuclear Power Plant Accident

#### 3.1.1. Summary of residents' support activities

A wide range of organizations including authorities, universities, research institutes, non-profit organizations (NPOs), and non-governmental organizations (NGOs implemented support activities for residents after the Fukushima Daiichi nuclear power plant accident), we identified 33 items (Table 1), of which 23 were related to dose measurements, including dose evaluation results plotted on the Google map so that any person could confirm the exposure dose [6]. In addition, there have been many types of initiatives to improve the quality of life of residents, especially the International Commission on Radiological Protection (ICRP) dialogue seminar, a project which has continued from several months after the Fukushima nuclear accident in 2011, thereby contributing to the spread of lifestyle knowledge of residents' lives and residents' activities [7, 8]. There were also 9 cases of residents' support for food safety issues, such as food radioactivity concentration. This project not only supports residents on how to measure the radioactivity concentration of food, but also provides information on the significance of the results and on which foods have a high radioactivity concentration in order to help a reduce the internal exposure of residents [7]. In addition, there were 6 cases of support for the physical health

effects of the residents and 3 cases of support for psychological effects. As shown in No. 1 in Table 1, the Fukushima Health Management Survey, conducted by Fukushima Medical University, is a large-scale health management survey on residents'/evacuees' health consisting of a basic survey and four detailed surveys ("Comprehensive Health Check", "Thyroid Ultrasound Examination", "Mental health and Lifestyle Survey", and "Pregnancy and Birth Survey") [9]. These surveys were linked with support services and served as a data source for the overall assessment of residents' health status and the provision of individualized health services.

### 3.1.2. Utilization of Health Applications in Fukushima (Table 1 No.2)

The "Fukushima Prefecture Resident Health Card", designed for the residents of Fukushima, allows them to use tools such as a pedometer and management of exercise and body weight via a mobile application for the purpose of improving physical activity. Targets are set for each of these measurements, and points are added when a target is achieved. These points can be used at cooperating facilities in Fukushima Prefecture for discounts on selected items, etc. This health application tool will be a help ameliorate the negative physical and psychological effects resulting from the feeling of helplessness that arises in the local population after a nuclear accident.

### 3.1.3. Amelioration of Physical and Psychological Effects due to Radiation Measurement

For people returning from an evacuation after a nuclear accident, it is important to control exposure doses at their homes. After the Fukushima Daiichi nuclear power plant accident, the Nagasaki University stationed public health nurses with knowledge of radiation to attend people returning to Kawauchi Village (Table 1 No. 7) [10]. These nurses provided instruction regarding how to use the device to measure ambient doses, how to manage exposure using the personal dosimeter, how to measure radioactivity concentration in food, and recommendations for physical health management methods. As a result, the residents were better informed and learned to coexist with radiation in their daily lives.

The D-shuttle project (Table 1 No. 8) was an attempt to show the individual dose in everyday life with a dosimeter (D-shuttle), which measures individual doses every hour in high school students [11]. These data allowed linking (and thereby predicting) individual behaviour with external exposure doses. This information can have a positive effect for the residents, who may conduct their daily activities residents without behavioral restrictions due to anxiety concerning radiation exposure. The D-shuttle was also used in the Miyakoji District of Tamura City, which raised awareness among residents and helped them coexist with radiation [12].

### 3.1.4. Guide for Stakeholders

With limited information, it is necessary for stakeholders to support with residents to improve the living environment and minimize physical and psychological effects after a nuclear accident. Following the Fukushima Daiichi nuclear power plant accident, the "Living Guide", a handbook for community workers (Table 1 No.23), was published. This book contains information and tips on how to answer the questions of residents returning to their homes. In addition, there was also a handbook on how to communicate health information in an easy-to-understand manner to residents, including a glossary to paraphrase professional terms and an index to assess and improve accessibility of written health information (Table 1 No. 22) as part of a health literacy toolkit for municipal public health nurses [13].

Because it is necessary for stakeholders to clearly communicate the radiation and health-related contents to residents in easy-to-understand ways, such handbooks are extremely valuable to facilitate interactive communication.

### 3.2. Concepts of Investigation on Long-Term Health and Well-being During a Nuclear Accident

The following concepts are considered as a mobile application tool in the present study,

- Alert radiation exposure to citizens (radiation protection)
- Help reduce anxiety and concerns to health effect of radiation exposure
- Help improve their quality of life
- Share the information of radiation exposure and safety
- Inform on possible radiation effects, in advance
- Promote radiation culture
- Address health issues in general (to enable residents to make well balanced health-related decisions)
- Facilitate community participation in the face of a health crisis

#### 3.2.1. Basic Concepts of the Application

As shown in Table 2, the basic concept of the application is created by subdividing the tools according to the number of persons using the application, the age band of the users, the period of use, and the contents of feedback. The level of feedback concerning health and well-being is set by the level of severity. In addition, it is necessary to verify whether security problems and actual needs to manage collected health and well-being information are applicable.

#### 3.2.2. Expected Impact and Tools of the Application

As listed in Table 3, application tools needed for surveying health and well-being should be based on guidelines for investigation of well-being such as the United Nations Development Programme, OECD Sustainable Development, Solutions Network, National Bhutan Research Centre, and the UN's 17 Sustainable Development Goals (SDGs)(<http://www.who.int/sdg/en/>) from the World Health Organization (WHO)). However, because these indicators are the contents of the survey of well-being in the nation, it is the authors' opinion that the parts conforming to the concepts of the present study should be extracted and a concept of well-being survey that is matched to the regional scale should be created. Ultimately, correspondence should be made so that the chart formula is shown in a regional scale as shown in Figure 1.

Table 4 shows the application tools necessary for actual investigation of health and well-being. As a representative example of the application, it is important to use information on research activities conducted worldwide such as e-Health/m-Health (Mobile App). In addition, the utility of general mobile applications such as quality of sleep, intensity of physical activity, and psychological test was suggested. Moreover, these contents need to be adapted to each age band, and when considering children, the use of child-friendly tools (e.g., CFC survey tools) should be considered. Finally and most importantly, implementation of such data collection tools should be accompanied by careful management of information security and support services responding to identified needs.

#### 4. Conclusion

To summarise, the resident support activities in the Fukushima Daiichi nuclear power plant accident, regarding radiation measurement (e.g., ambient dose, individual exposure dose, food radioactivity levels) improved the health and well-being of residents. It was also shown that the presence of a handbook on radiation knowledge and radiation protection measures to help professionals support residents is important. The results of the present study revealed that mobile applications that respond to nuclear accidents should collect information from local residents based on well-being indicators such as those defined by the SDGs, and taking into consideration the age range and number of subjects. In fact, we conclude that it is important to combine the tools commonly used by residents while utilizing the information of the research activities conducted globally to drive the direction of mobile applications. Such tools and efforts should be culturally adapted, implemented in an acceptable for the community, and linked with appropriate services to respond to identified needs.



Table 1. Residents' support activities after the Fukushima Daiichi nuclear power plant accident

No.	Title	Subject	Periods	Place	Devise or research too	Exposure dose level	Quality of life	Diet	Stress	Health in general	Maternal and child health	Thyroid examination	Other	URL
1	Fukushima Health Management Survey (FHMS) [9]	Residents/evacuees	From June, 2011	Lived in Fukushima Prefecture at the Fukushima accident	Questionnaires	x	x		x	x	x	x		<a href="http://fmu-global.jp/">http://fmu-global.jp/</a>
2	Fukushima keeping health card project	Residents (more than 18 y.o.)	From February, 2016	Living in Fukushima Prefecture	App		x	x		x				<a href="http://kenkou-fukushima.jp/">http://kenkou-fukushima.jp/</a>
3	The Fukushima Ambassadors Program	Foreign students in Fukushima University	From 2014	Fukushima	-	x			x	x			Hands-on learning	<a href="http://english.adb.fukushima-u.ac.jp/program/ambassadors-program.html">http://english.adb.fukushima-u.ac.jp/program/ambassadors-program.html</a>
4	The Fukushima Future Center for Regional Revitalization (FURE)	Evacuees (Returned evacuation area) and Fukushima University	From April, 2011	Fukushima	-	x		x			x		Reconstruction	<a href="http://fure.net.fukushima-u.ac.jp/">http://fure.net.fukushima-u.ac.jp/</a>
5	ICRP Dialogue initiative [7, 8]	Residents/evacuees/ local media	From December, 2011-2015	Local area in Fukushima Prefecture	Dialogue including radiation measurement	x	x	x			x			<a href="http://ethos-fukushima.blogspot.jp/p/icrp-dialogue.html">http://ethos-fukushima.blogspot.jp/p/icrp-dialogue.html</a>
6	Fukushima Dialogue (continuing the dialogue in corporation with ICRP)	Residents/evacuees/ local media	From 2016-today	Local area in Fukushima Prefecture	Dialogue including radiation measurement	x	x							<a href="http://ethos-fukushima.blogspot.jp/p/icrp-dialogue.html">http://ethos-fukushima.blogspot.jp/p/icrp-dialogue.html</a>
7	Nagasaki University/Kawauchi Village Reconstruction Promotion [10]	Evacuees (Returned evacuation area)	From April, 2013	Kawauchi Village	Radiation detector	x	x	x		x			Reconstruction	<a href="http://www-sdc.med.nagasaki-u.ac.jp/abdi/bases/kawauchi_e.html">http://www-sdc.med.nagasaki-u.ac.jp/abdi/bases/kawauchi_e.html</a>
8	D-Shuttle Project [11]	High school students	June-July, 2014 in Japan November, 2014 in Europe	Fukushima Prefecture, Kanagawa, Gifu, Nara, Hiroshima Prefecture, and France, Poland, Belarus	D-Shuttle	x							Record of behaviour	<a href="http://www.fukushima-fks.ed.jp/jok6crg82-28/?action=common_download_main&amp;upload_id=1007">http://www.fukushima-fks.ed.jp/jok6crg82-28/?action=common_download_main&amp;upload_id=1007</a>

No.	Title	Subject	Periods	Place	Devise or research too	Exposure dose level	Quality of life	Diet	Stress	Health in general	Maternal and child health	Thyroid examination	Other	URL
9	Citizen-led SAFECAST project is a Volunteered Geographical Information [6]	Residents in the world including evacuees in Fukushima	From April, 2011	Worldwide	Radiation detector	x	x						Google map	<a href="https://blog.safecast.org/">https://blog.safecast.org/</a>
10	Fukushima Wheel Project	Citizens	From 2012	Fukushima for Worldwide	SAFECAST devise	x							Bike with radiation dosimeter	<a href="http://fukushimawheel.org/">http://fukushimawheel.org/</a>
11	Radioactive Contamination and Citizen Science after Fukushima (Japanese)	Citizens	From 2016	West Japan	SAFECAST devise	x							Citizen science	<a href="http://networkofcs.srv.jp/">http://networkofcs.srv.jp/</a>
12	Fukushima center for Disaster mental health	Residents/evacuees	From 2012	Fukushima Prefecture	-						x			<a href="http://kokoro-fukushima.org/english-page/">http://kokoro-fukushima.org/english-page/</a>
13	Program of International Medical Corps	Residents for The Great East Japan Earthquake	From 2011	Japan	-		x						Support to local NGO	<a href="https://internationalmedicalcorps.org/country/japan/">https://internationalmedicalcorps.org/country/japan/</a>
14	Association for Aid and Relief JAPAN (AAR)	Residents for The Great East Japan Earthquake	Apr. 2011-Dec. 2014	Japan	Radiation detectors were presented to Soma City.	x	x	x						<a href="http://www.aarjapan.gr.jp/english/where_work/japan/">http://www.aarjapan.gr.jp/english/where_work/japan/</a>
15	Japan International Volunteer Center (JVC)	Residents for The Great East Japan Earthquake	From May 2011	Minamisoma City	-		x						Supporting the Operation of Temporary Housing Salons	<a href="http://www.ngo-jvc.net/en/ourprojects/minamisoma-fukushima-pref-great-east-japan-earthquake/">http://www.ngo-jvc.net/en/ourprojects/minamisoma-fukushima-pref-great-east-japan-earthquake/</a>

No.	Title	Subject	Periods	Place	Devise or research too	Exposure dose level	Quality of life	Diet	Stress	Health in general	Maternal and child health	Thyroid examination	Other	URL
16	Fukushima Booklet Committee Citizens' Initiative	Fukushima Booklet Committee (NPO)	From 2015	Fukushima, Tokyo	-								Booklet	<a href="http://fukushimalessons.jp/index.html">http://fukushimalessons.jp/index.html</a>
17	Resurrection of Fukushima	Evacuees (Returned evacuation area)	From October, 2011	litate Village	Radiation detector	x	x			x			Reconstruction	<a href="http://www.fukushima-saisei.jp/en/en-purpose/">http://www.fukushima-saisei.jp/en/en-purpose/</a>
18	Shalom Disaster Relief Center Fukushima radiation measurement information site	Residents	From 2015	Fukushima Prefecture	Radiation detector	x							Measurement data with roadside	<a href="http://nposhalom.sakura.ne.jp/hsf/">http://nposhalom.sakura.ne.jp/hsf/</a>
19	Fukushima 30-year project	Education for residents	From August, 2012	Fukushima Prefecture	Radiation detector for food and WBC	x		x					Measurement data with WBC	<a href="https://fukushima-30year-project.org/">https://fukushima-30year-project.org/</a>
20	Life Agriculture Fukushima	Food measurement	From 2011	Fukushima Prefecture	Radiation detector for food	x		x						<a href="http://npo-leaf.org/">http://npo-leaf.org/</a>
21	Mothers' Radiation Lab Fukushima	Residents	From 2011	Iwaki City	Radiation detector for food and WBC	x		x			x	x	Food measurement and WBC	<a href="https://tarachineiwa.ki.org/english">https://tarachineiwa.ki.org/english</a>
22	Health Literacy Promotion Toolkit [13]	Health professionals	From 2016	Japan	Booklet of tips for improving communication (including Clear Communication Index)								Health Literacy	TBA in 2018
23	Hints of Life in Hometown	Radiation consultants and other local professionals	From 2017	Fukushima Prefecture	Booklet of tips of how to discuss about radiation	x	x	x	x	x	x	x		TBA in 2018
24	Volunteered Geographical	Voluntary citizens	-	-	Radiation detector	The data are visualized using Google Fusion Tables to produce maps. VGI is sourced from social media platforms, such as Twitter, Facebook, and						Google map	-	

No.	Title	Subject	Periods	Place	Devise or research too	Exposure dose level	Quality of life	Diet	Stress	Health in general	Maternal and child health	Thyroid examination	Other	URL
	Information (VGI)					Instagram to study a variety of subjects including natural hazards, demographics, and health.								
25	US National Atmospheric Release Advisory Center (NARAC)	Scientific data	In 2011	Japan	Simulation	x							Dose map	<a href="https://narac.llnl.gov/">https://narac.llnl.gov/</a>
26	Database for Radioactive Substance Monitoring Data	Scientific data	From 2011	Japan	Measurement data	x							Dose map	<a href="http://emdb.jaea.go.jp/emdb/en/">http://emdb.jaea.go.jp/emdb/en/</a>
27	Fukushima Prefectural Centre for Environmental Creation in Miharu town	Scientific data & o. Communication and Educational Activities	From 2017	Fukushima Prefecture	Measurement data	x								<a href="https://www.fukushima-kankyosozojp.org/index.html">https://www.fukushima-kankyosozojp.org/index.html</a>
28	Fukushima Global Communication Program	Event, discussion etc..	Apr. 2013-Mar. 2016	Fukushima Prefecture	-								Preparation to lessons learned	<a href="https://fgc.unu.edu/en/">https://fgc.unu.edu/en/</a>
29	The Citizen Sense project	Citizens	From Jan. 2013	Worldwide, not Japan	Environmental data	To investigate the relationship between technologies and practices of environmental sensing and citizen engagement								<a href="https://citizensense.net/">https://citizensense.net/</a>
30	Yamakiya Gakko	Local residents and outside expert	From 2012	Yamakiya, Kawamata	Measurement, Dialogue	x								
31	Misho Project	Local residents and outside expert	From 2011	Miharu	Measurement, Dialogue	x								<a href="http://fukushima-misho.com/miharu/index.php?id=57">http://fukushima-misho.com/miharu/index.php?id=57</a>
32	Team Bishamon	Local residents	From August, 2011	Iitate, Minamisoma, Namie	Measurement, Dialogue	x								<a href="http://www.med.niigata-u.ac.jp/contents/research/results/pdf/minami_r_1.pdf#search=%27Team+Bishamon+%E6%94%BE%E5%B0%84%E7%B7%9A%27">http://www.med.niigata-u.ac.jp/contents/research/results/pdf/minami_r_1.pdf#search=%27Team+Bishamon+%E6%94%BE%E5%B0%84%E7%B7%9A%27</a>
33	Mirai kaigi	Local residents	From 2013	Hamado-ri	Dialogue		x							<a href="http://miraikaigi.org/">http://miraikaigi.org/</a>

Table 2. Basic concept at Task 3.1

Items	Details	Comments
<b>Population level</b>	~1,000, ~10,000, ~100,000	To modify App's contents (short questionnaires) on population level.
<b>Age</b>	Children/students, Adults/Mother, Elderly	To modify App's contents (short questionnaires) on ages.
<b>Period (When feasible)</b>	Preparedness, After a nuclear accident	It is desirable to enter participant's basic information, in advance.
<b>Feedback (After filling in questionnaire, citizens would wait feedback.)</b>	Health, Diet, Quality of life, Mental health	It is difficult to reply comments of mental health because citizens can't take countermeasure.
<b>Data security</b>	Personal information	Who connects and handles this questionnaire data?
<b>Understanding needs</b>	Citizen Advisory Board members in Fukushima	Ask their needs in Fukushima accident. These needs can be reflected our questionnaire.

Table 3. List of well-being indicators

Index		Human Development Index ( <a href="http://hdr.undp.org/en/content/human-development-index-hdi">http://hdr.undp.org/en/content/human-development-index-hdi</a> )	Better Life Index ( <a href="http://www.oecdbetterlifeindex.org/">http://www.oecdbetterlifeindex.org/</a> )	World Well-being ( <a href="http://unsdsn.org/">http://unsdsn.org/</a> )	Gross National Well-being ( <a href="http://www.grossnationalwell-being.com/">http://www.grossnationalwell-being.com/</a> )
<b>Research centre</b>		United Nations Development Programme	OECD	Sustainable Development Solutions Network (UN)	National Bhutan research centre
<b>Factor</b>	Economy/ Poverty	<ul style="list-style-type: none"> <li>GDP per capita (gross national product) calculated by purchasing power parity</li> </ul>	<ul style="list-style-type: none"> <li>Income</li> <li>Employment</li> </ul>	<ul style="list-style-type: none"> <li>Real GDP per capita (gross national product)</li> </ul>	-
	Education	<ul style="list-style-type: none"> <li>Adult literacy rate (15 years and over)</li> <li>Comprehensive elementary / secondary / higher education total enrolment rate</li> </ul>	<ul style="list-style-type: none"> <li>Education and skills</li> </ul>	-	<ul style="list-style-type: none"> <li>Education</li> <li>Culture</li> </ul>
	Health/ Environment	<ul style="list-style-type: none"> <li>Life expectancy at birth (average life expectancy)</li> </ul>	<ul style="list-style-type: none"> <li>Health condition</li> <li>Quality of the environment</li> </ul>	<ul style="list-style-type: none"> <li>Healthy life</li> </ul>	<ul style="list-style-type: none"> <li>Health</li> <li>Environment</li> </ul>
	Life/Society	-	<ul style="list-style-type: none"> <li>Housing circumstances</li> <li>Community, social connection</li> <li>Citizen involvement and governance</li> <li>Life satisfaction</li> <li>Personal safety</li> <li>Work life balance</li> </ul>	<ul style="list-style-type: none"> <li>Freedom of choice for individual's life</li> <li>Social support</li> <li>Latitude</li> <li>Low corruption level</li> <li>Political freedom</li> </ul>	<ul style="list-style-type: none"> <li>Psychological well-being</li> <li>Community</li> <li>Good governance</li> <li>Standard of living</li> <li>How to use your own time</li> </ul>

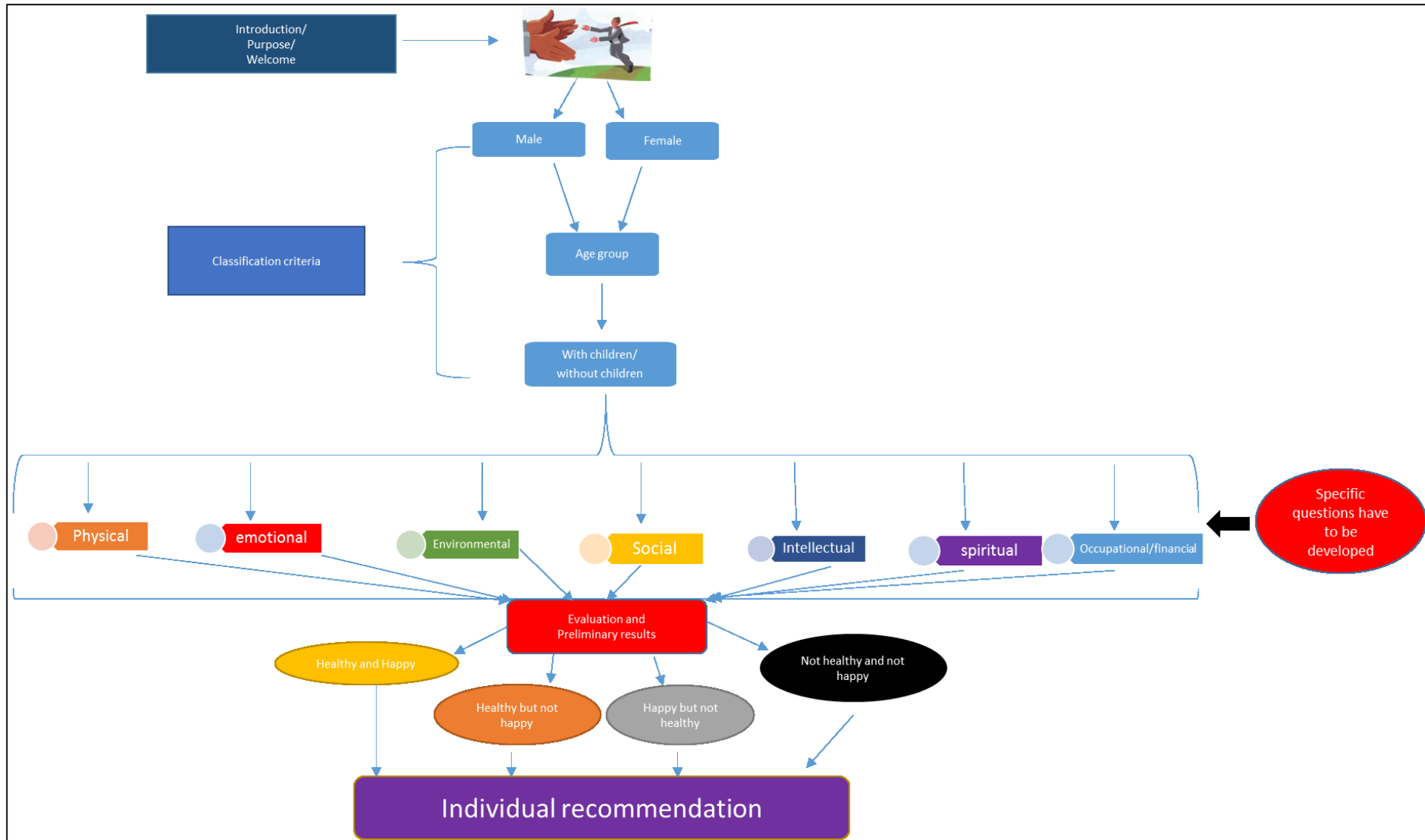


Figure 1. Mobile application and tools from input to output

Table 4. List of mobile application and tools

Model projects	Tools	Comments
<b>e-Health/m-Health (Mobile App) used in developing countries</b>	Questionnaire, Health services combined	<a href="https://cdn1.sph.harvard.edu/wp-content/uploads/sites/21/2012/12/w12_mhealth.pdf">https://cdn1.sph.harvard.edu/wp-content/uploads/sites/21/2012/12/w12_mhealth.pdf</a>
<b>Quality of sleep</b>	Mobile application system	To assess mental health.
<b>Intensity of physical activity</b>	Mobile application system	To assess physical activity.
<b>Psychological test</b>	Questionnaire	Change test level for student to elderly.
<b>Child-friendly tools e.g. CFC survey tools</b>	Face scale Drawing Mobile application system	Mobile application system



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