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# Intervention Research for Quality of Life Improvement Through the Use of Personal Mobility Mode in an Aging Society

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**Abstract**: Transport mobility appears to be closely linked to a person's well-being, especially for elderly people. The development of specialized transport devices to compensate for the decline in mobility of the elderly is important so that they may move around and lead an independent life as they wish. Mobility devices such as electric carts offer great utility for transport; however, the electric cart has yet to gain popularity in the open market. Thus, it is necessary to examine ways of expanding the usage of such devices and to clarify their effects on improving the quality of life of the elderly. Here, we investigate the change in the quality of life from the viewpoint of health and welfare with the use of personal mobility mode, in the daily life of the elderly using various types of evaluation measurements.

***Keywords***: *Personal mobility, Quality of life, SF-36, Life space assessment, International classification of functioning, Aging society.*

## 1. INTRODUCTION

For the elderly whose physical functions have declined, in order to be able to move as they wish and to achieve a degree of independence, the development of specialized transportation devices that may compensate for this decline is important. Transportation devices include what are called personal mobility (PM) modes, for example, wheelchairs and electric carts. However, their use has not yet been widely accepted in Japan. It is therefore necessary to clarify the reasons for this and examine new practical uses for PM modes.

When PM mode is used as a transportation device, the kinds of change that result in terms of quality of life (QOL) for the user should be evaluated. The primary aim of this study is to clarify the effects on QOL from the viewpoint of health and welfare with the use of PM modes such as electric scooters as used by elderly people so that they may continue with their participation in social activities despite their difficulties in moving over a long distance or for a long time.

It appears that transport mobility often closely affects a person's well-being, that is, one's QOL; however, this link is not well understood. Recently, some studies on how

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transport mobility contributes to enhancing QOL have been carried out. Spinney *et al.* (2009) sought to quantify the impacts of transport mobility and investigated them on QOL. Their results showed significant variations in transport mobility according to life situation and subjective QOL indices; they also showed a significant relationship between transport mobility and QOL. Stanley *et al.* (2011) confirmed that there is a significant association between increased mobility and improved personal well-being through the reduction of social exclusion risk and the development of social capital.

However, these studies analyzed the relationships between a person's subjective well-being and transport mobility as performed by general transport modes, such as cars and public transport. However, it is very difficult not only to define individual subjective well-being itself, but also to measure it because mobility is one of factors that constitute well-being.

Research on QOL through the maintenance of roads and the provision of public transport services on QOL improvement was conducted by Eitoku *et al.* (2010), Mizokami *et al.* (2010), and Mizokami *et al.* (2012). The latter study appears to be the first examination of the effectiveness for improvement in QOL by PM modes such as electric carts. However, we are not aware of any research that verifies the effects on QOL by PM modes that synthesizes both health and welfare evaluation measurements. The purpose of this paper is thus to focus on PM mode as one of a number of transport mobility modes and, in particular, to measure its impacts on well-being from the viewpoint of health and welfare.

In Kumamoto Prefecture in 2010, a study entitled "Verification Research on Providing Chargers that use Solar Power and New Ways to use Electric Vehicles such as Scooters" was conducted as a project supported by the Ministry of Internal Affairs and Communications to study a new method of utilizing PM modes and to evaluate the impacts on QOL. The Japanese Red Cross Society Kumamoto Health Management Center was the representative of this investigative research project in cooperation with Kumamoto Prefecture, several medical and welfare institutions, Kumamoto University, and HONDA Motor Co., Ltd as an industry–government–academia collaboration research project.

## 2. INTRODUCTION OF PERSONAL MOBILITY AND INTERVENTION FIELDS

### 2.1 Personal Mobility

Personal mobility is defined as a transportation device such as an electric-assisted bicycle or an EV motorbike that bridges the gap between walking and conventional transport modes. We focus here on the electric wheelchair.

There are two common configurations of electric wheelchairs: those using joysticks and those using handles for operation. Wheelchairs that are manufactured for elderly people have a user group on average in their 70s. In Japan, the volume of production in 2008 was 22,957 units (joystick: 5,826 units; handle: 17,131 units), indicating there are many more of the handle type than the joystick type. The current production of handle-type wheelchairs has decreased by about 40 percent from 29,121 units in 2000 (Figure 1). One reason for this decrease is the requirement for authorization that care is necessary in order to rent a wheelchair, which was mandated by the Long-term Care Insurance Law. Those who do not receive care authorization are presumed to be independent and thus cannot receive nursing care insurance for wheelchair rental but must cover the total amount individually.

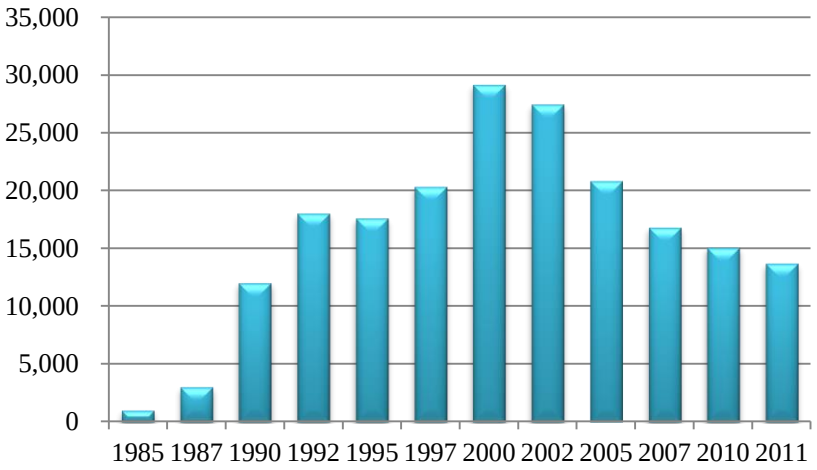



Figure 1. Shipment volume of handle form wheelchair

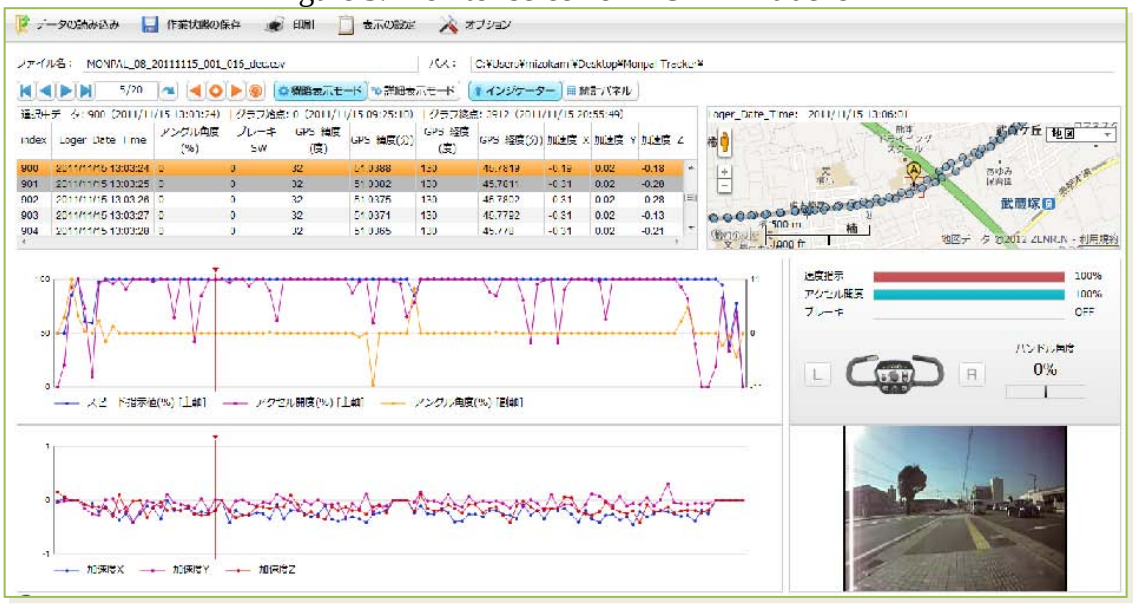
## 2.2 Specification of MONPAL

The personal mobility used for this intervention research is an electric wheelchair called MONPAL, which has been made by HONDA since 2006. MONPAL is designed for senior citizens with physical disabilities, to enable them to move freely with ease. It is classified by the Traffic Rules of Japan as an electric wheelchair for physically challenged people. Key standards stipulated in the Japanese Road Traffic Act are that 1) dimensions must be limited to no more than 120 × 70 × 109 cm; 2) it must possess an electric motor; and 3) driving speed must be limited to 6 km/h. MONPAL's specifications are shown in Figure 2. Operators of MONPAL are classed as pedestrians, so they do not need a driver's license. However, there are legal restrictions for approved sizes and speeds.


Figure 2. Characteristics of MONPAL

We equipped our test MONPAL with a data logger that records GPS tracking and operation data and a communication device that transmits these data at intervals for a set period of time. The latest MONPAL has also been equipped with a three-dimensional accelerometer and a driving camera that enables visualization of the driving environment to recognize actual points on the roadway where the level of acceleration varies suddenly. MONPAL Tracker, as we named our device, can monitor these data simultaneously (Figure 3).

Figure 3. Monitor screen of MONPAL tracker



## 3. INTERVENTION FIELDS AND QOL EVALUATION METHODS

### 3.1 Intervention Fields and Subjects

Three fields were selected for the scenarios of social intervention in 2010.

*Field A: Elderly shared-use urban-life model scenario*
Field A is collective housing for elderly people in the center of Kumamoto city. Residents depend for everyday movement on foot or taxi. We recruited three residents as subjects to verify the possibility of shared use to visit adjacent retailers, medical clinics, and so on.

*Field B: Healthy person life-base model scenario*
Field B consists of health and cultural facilities in a suburban area of Kumamoto city. Many elderly people go there for exercise and cultural events. Although they live in close enough proximity to go on foot, most use cars or motorbikes. We lent out PM modes to five subjects and had them use the PM mode freely so that we could verify aspects of individual possession type use.

*Field C: Nursing home shared-use model scenario*
Field C is a nursing home in the suburbs of Kumamoto city. Those who reside there have poor walking ability. There are few opportunities for them to move on foot. We decided to verify aspects of private ownership use by one tenant and shared use by three daycare services.

### 3.2 QOL Evaluation Methods

To evaluate the degree of improvement in QOL, PM modes were lent out for a period to subjects who had never used them; various QOL index values were compared before and after MONPAL use.

*a) Medical Outcomes Study 36-Item Short-Form (SF-36)*

On the SF-36.org website, Ware (2014) gives a summary of the SF-36 as follows.

> *The SF-36 is a multipurpose, short-form health survey with 36 questions. It yields an 8-scale profile of functional health and well-being scores as well as psychometrically based physical and mental health summary measures and a preference-based health utility index" shown in Table 1. "It is a generic measure." "Accordingly, the SF-36 has proven useful in surveys of general and specific populations, comparing the relative burden of diseases, and in differentiating the health benefits produced by a wide range of different treatments.*

Table 1. Summary of information about SF-36 scales and physical and mental components

| Scales | Definition (% observed) | |
|---|---|---|
| | Lowest Possible Score (Floor) | Highest Possible Score (Ceiling) |
| Physical Functioning (PF) | Very limited in performing all physical activities, including bathing or dressing (0.8%) | Performs all types of physical activities including the most vigorous without limitations due to health (38.8%) |
| Role-Physical (RP) | Problems with work or other daily activities as a result of physical health (10.3%) | No problems with work or other daily activities (70.9%) |
| Bodily Pain (BP) | Very severe and extremely limiting pain (0.6%) | No pain or limitations due to pain (31.9%) |
| General Health (GH) | Evaluates personal health as poor and believes it is likely to get worse (0.0%) | Evaluates personal health as excellent (7.4%) |
| Vitality (VT) | Feels tired and worn out all of the time (0.5%) | Feels full of pep and energy all of the time (1.5%) |
| Social Functioning (SF) | Extreme and frequent interference with normal social activities due to physical and emotional problems (0.6%) | Performs normal social activities without interference due to physical or emotional problems (52.3%) |
| Role-Emotional (RE) | Problems with work or other daily activities as a result of emotional problems (9.6%) | No problems with work or other daily activities (71.0%) |
| Mental Health (MH) | Feelings of nervousness and depression all of the time (0.0%) | Feels peaceful, happy, and calm all of the time (0.2%) |

Source: Edited based on the information from "http://www.sf-36.org/tools/SF36.shtml".

*b) Life-Space Assessment (LSA)*

Daily physical activity was evaluated using life-space assessment (LSA), an instrument developed at the University of Alabama at Birmingham (Baker *et al.* 2003). LSA can assess movement ability that takes into account life-space level, degree of independence, and frequency of attainment.

Life-space level is defined as the distance from the origin point of life-space, which is the bedroom, and is classified into six levels: life-space 0, the bedroom; life-space 1, the home; life-space 2, the immediate outside; life-space 3, the neighborhood; life-space 4, the

town; and life-space 5, unlimited. LSA score is calculated by the sum of (the life-space level) × (degree of independence) × (frequency of attainment) for all life activity, with a minimum score of 0 and maximum of 120.

*c) International Classification of Functioning, Disability, and Health (ICF)*

The International Classification of Functioning, Disability, and Health (ICF) classifies health and health-related domains from physical, individual, and societal perspectives by means of not only a list of body functions and structure but also of a list of activity and participation.

ICF suggests application-specific research tools for measuring QOL for all persons regardless of whether they have an illness or disability, so we determined that these tools are suitable for use as a QOL evaluation index for the subjects of this research. MONPAL is used as a means of transportation, so we deemed it to be especially suitable for evaluation using ICF composition elements of activity and participation. Details of actual classification items that we created, including several original questions, are explained below.

### 3.3 Data Collection

Table 2 shows the attributes of 26 persons who agreed to be subjects of the intervention survey initially.

Table 2. Attributes of all 26 subjects

| CODE | ID | ICF ID | Use frequency | Sex | Consent by family | Pre-medical exam | Pre-TUG grip | Post-medical exam | Post-TUG grip |
|---|---|---|---|---|---|---|---|---|---|
| A-1 | 1 | L | | M | △ | ○ | ○ | ○ | ○ |
| A-2 | 2 | K | | M | ○ | ○ | ○ | ○ | ○ |
| A-3 | 3 | J | ◎ | F | △ | ○ | ○ | ○ | ○ |
| B-3 | | | | F | | | | | |
| B-4 | | | | F | | | | | |
| B-5 | 4 | B | ○ | M | ○ | ○ | ○ | ○ | ○ |
| B-6 | 5 | A | ◎ | M | ○ | ○ | ○ | ○ | ○ |
| B-7 | 6 | | × | M | ○ | ○ | × | × | × |
| B-8 | 7 | C | ◎ | M | ○ | ○ | × | ○ | △ |
| B-9 | | | | F | | | | | |
| B-10 | | | | F | | | | | |
| B-11 | 8 | D | ○ | M | ○ | ○ | ○ | ○ | ○ |
| B-12 | | | | F | | | | | |
| B-13 | | | | M | | | | | |
| B-14 | | | | M | | | | | |
| B-15 | | | | F | | | | | |
| B-16 | | | | F | | | | | |
| B-17 | | | | M | | | | | |
| B-18 | 9 | E | △ | F | ○ | ○ | × | ○ | ○ |
| B-19 | | | | M | | | | | |
| C-1 | 10 | I | ◎ | M | ○ | ○ | ○ | ○ | ○ |
| C-2 | 11 | H | ○ | F | ○ | ○ | ○ | ○ | ○ |
| C-3 | 12 | G | | F | ○ | ○ | ○ | ○ | ○ |
| C-4 | 13 | F | × | F | ○ | ○ | ○ | × | × |

Note: 1) ◎, ○, △, and × in use frequency show frequently, sometimes, rarely, and not at all, respectively; 2) ○, △, and × in consent by family and so on show completely, almost, and not at all, respectively.

The intervention survey of fields A–C was conducted according to the schedule shown in Figure 4. Before the actual intervention, a pre-questionnaire on preferences for and impressions of the MONPAL was given to subjects as a trial run. Results are shown in Table 3. Subjects who were unfamiliar with MONPAL comprised over 70% of the total, meaning that name recognition of MONPAL as an electric cart was unexpectedly low. Many subjects felt it was easy to operate and had a good impression after the trial. On the other hand, half of all subjects responded that it was difficult for them to drive safely and at ease, which indicates the existence of certain psychological barriers against acceptance of MONPAL.

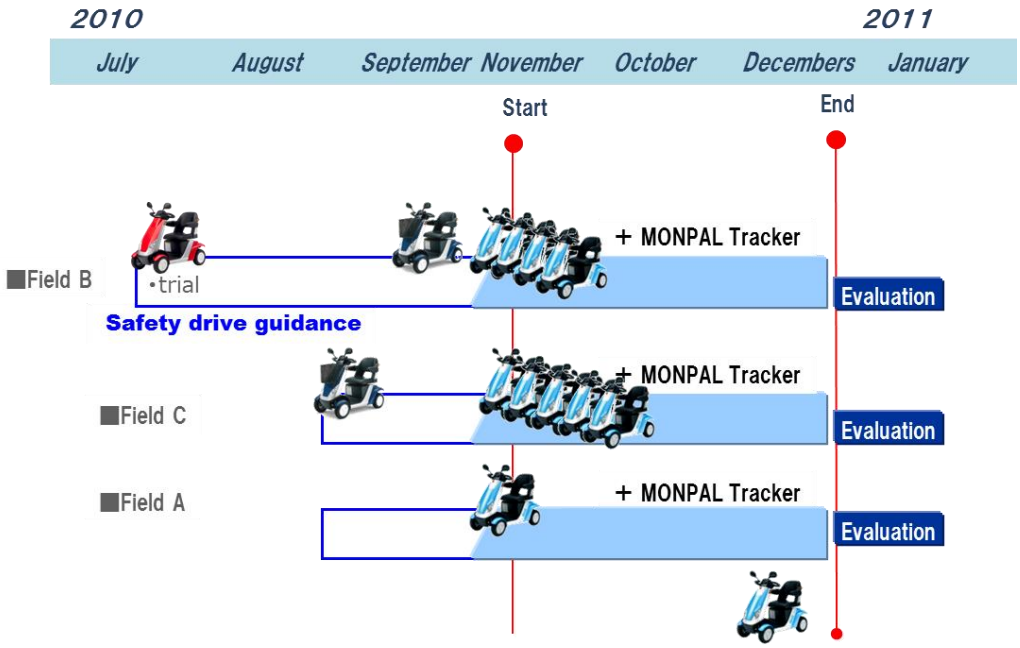



Figure 4. Schedule of interventions

Table 3. Results of pre-questionnaire survey

| Question item | Answer | Comments ( [ ]: the number of subjects who answered the item) |
|---|---|---|
| 1. Sex | male [3], female [4] | |
| 2. Age | fifties [1], sixties [1], seventies [2], eighties [3] | |
| 3. Degree of care | care-1 [3], care-2 [3], care-3 [1] | |
| 4. Driver"s license | with [4], without [3] (2 returned because of age) | |
| 5. Are you familiar with MONPAL? | no [5] | |
| | yes [2] (their friends have been using) | |
| 6. What do you think about MONPAL after trial run? | good [6] | /better than car<br>/speed is appropriate<br>/stable and easy to drive with one hand |
| | Not good [1] | /afraid of driving and accidents |
| 7. What do you think about its operation? | easy [6] | /easy to drive regardless of paralysis in left half side of the body<br>/easy if once practice |
| | difficult [1] | /hard to operate accelerator levers |
| 8. Can you drive with ease? | yes [4] | /easy if once practice a little |
| | no [3] | /worry about driving without attendant |

Table 3. Results of pre-questionnaire survey (continued)

| Question item | Answer | Comments ( [ ]: the number of subjects who answered the item) |
|---|---|---|
| 9. What do you think about the price? | expensive [3] | /appropriate if price is the same as a scooter |
| | reasonable [1] | |
| | unknown [3] | |
| 10. Do you plan to continue use hereafter? | yes [4] | /for shopping [2], go to the hospital [3], friends [1]<br>/drive within 2km distance<br>/go to go parlor by it in place of car |
| | no [3] | /taxi is much easier to take<br>/prevent decline of muscle |
| 11. What is your impression? | /need 10km/h in maximum speed<br>/rental system<br>/go outside and take pictures<br>/want to drive by myself<br>/need much wider basket | |

The SF-36 and LSA pre-questionnaire surveys were conducted with respect to all 26 subjects before the social intervention via a face-to-face interview, in addition to medical examinations and the TUG grip test. We expected all 26 subjects to participate in the social intervention. However, 13 subjects did not participate in the intervention test at all or only partly and were eventually excluded from the survey. As a result, the remaining 13 subjects with ID numbers 1 – 13 (shown in the second column in Table 2) were invited to participate in the post-questionnaire survey.

## 4. RESULTS OF QOL EVALUATION

### 4.1 Changes in SF-36™ (Norm-Based Scoring)

The average scores on the 8-scale profile of SF-36 were standardized to norm-based scoring (NBS) both before and after the intervention (Figure 5). The number of samples is fairly small, so we cannot use the usual t-test to assess the difference in average of population. In such a case, we can use the Wilcoxon signed-rank test, which is a nonparametric statistical hypothesis test used when comparing two related samples to assess whether their population mean ranks differ. The average in NBS of SF-36 of only two items, Role Physical (RP) and Role Emotional (RE), improved from before the intervention with statistically significant differences. On the other hand, the average of other items declined slightly without statistically significant differences.

The SF-36 questionnaire before using MONPAL was conducted on a comparatively warm day early in October. We conducted the same questionnaire survey after using MONPAL on a cold mid-December day. This is very likely the main reason why the scores of the physical components Physical functioning (PF), Body pain (BP), General health (GH), and Vitality (VT) declined.


| initial | Name of scale |
|---|---|
| PF | Physical functioning |
| RP | Role physical |
| BP | Bodily pain |
| GH | General health |
| VT | Vitality |
| SF | Social functioning |
| RE | Role emotional |
| MH | Mental health |

Figure 5. Averages of NBS in 8-scale profile of SF-36

### 4.2 Changes in LSA Score

Table 4 shows the differences in LSA scores of individual subjects before and after using MONPAL as well as his/her degree of frequency of use. LSA scores improved in four subjects, while declining in four subjects. However, there is a clear tendency that more frequent use of MONPAL leads to improvement in LSA scores and a wider activity sphere.

Table 4. Relation between LSA score and use frequency

| Field / Subject | | Before | After | Difference | Use frequency |
|---|---|---|---|---|---|
| A | 1 | 120.0 | 102.0 | -18/0 | △ |
| | 2 | 84.0 | 24.0 | -60.0 | △ |
| | 3 | 49.5 | 63.0 | 13.5 | ◎ |
| B | 4 | 102.0 | 120.0 | 18.0 | ○ |
| | 5 | 66.0 | 84.0 | 18.0 | ◎ |
| | 6 | 120.0 | - | - | × |
| | 7 | 84.0 | 84.0 | 0.0 | ◎ |
| | 8 | 120.0 | 63.0 | -57.0 | ○ |
| | 9 | 120.0 | 63.0 | -57.0 | △ |
| C | 10 | 22.5 | 54.0 | 21.5 | ◎ |
| | 11 | 120.0 | 120.0 | 0.0 | ○ |
| | 12 | 18.0 | - | - | × |
| | 13 | 19.5 | - | - | × |

Note: ◎, ○, △, and × in use frequency show frequently, sometimes, rarely, and not at all, respectively.

We divided the 13 subjects into either an improved group or a static group based on their LSA scores and compared the average differences in the 8-scale profile scores of SF-36 for both groups (Table 5). In the group whose LSA scores improved, the score of PF, BP and SF declined; however, the score of RP, GH, VT and RE improved. On the other hand, in the group whose LSA score was static or worsened, there was only improvement in the score of RP and RE.

Table 5. Relation between LSA and SF-36

| LSA \ SF-36 | | PF | RP | BP | GH | VT | SF | RE | MH |
|---|---|---|---|---|---|---|---|---|---|
| Improved Group | before | 83.8 | 79.7 | 71 | 50.8 | 75.0 | 90.6 | 75.0 | 76.3 |
| | after | 60.0 | 93.8 | 61.5 | 55.8 | 76.6 | 87.5 | 89.6 | 76.3 |
| | difference | -23.8 | 14.1 | -9.5 | 5.0 | 1.6 | -3.1 | 14.4 | 0.0 |
| Static or worsened Group | before | 75.0 | 46.9 | 62.5 | 66.0 | 57.8 | 68.8 | 35.4 | 73.8 |
| | after | 70.0 | 51.6 | 51.3 | 47.2 | 40.6 | 56.3 | 52.1 | 48.8 |
| | difference | -5.0 | 4.7 | -11.2 | -18.7 | -17.2 | -12.5 | 16.7 | -25.0 |

We can summarize the characteristics of each QOL measurement method from the abovementioned considerations as follows.

1) It appears that QOL by PM mode use cannot be fully assessed by only using SF-36, a comprehensive QOL evaluation method.
2) Conversely, PM mode use improves the LSA score, which reflects the subject's life-space activity. There is a weak correlation between the LSA score and SF-36.
3) This LSA score appears to explain the comprehensive evaluation score by SF-36 to some extent.
4) LSA clearly shows the degree of life-space activity, but it is unable to explain the purposes or methods relating to subjects' increase in life-space activity. Therefore, clarification of the types of functions including activities and participation that increase the LSA score is required.

## 5. QOL EVALUATION BY ICF

### 5.1 ICF Questions

Levels of activity (i.e., individual performance of problems or actions) and participation (i.e., engagement in life and life situations), which appear to be factors of ICF, should be evaluated. The use of ICF suggests application-specific research tools for measuring QOL for all persons through various types of functioning regardless of whether they have an illness or disability.

Unlike the scoring for a comprehensive evaluation index like SF-36, the contents of ICF allow for changes that affect part of an individual's lifestyle. MONPAL is used as a means of transportation, so we deemed it to be especially suitable for evaluation of ICF composition elements of activity and participation.

We proposed an interview guide with nine classification items based on "The use of ICF," which was created by the Ministry of Health, Labor, and Welfare (2007). From these nine classification items of functioning, we created 13 questions: 1) two questions on "learning and applying knowledge"; 2) two questions on "general tasks and demands"; 3) one question on "communication"; 4) one question on "mobility"; 5) one question on "self-care"; 6) one question on "domestic life"; 7) two questions on "interpersonal interactions and relationships"; 8) one question on "major life and areas"; and 9) two questions on "community, social, and civic life". Table 6 shows the narrative contents of these 13 questions.

### 5.2 QOL Evaluation by ICF

Using the interview guide, we conducted semistructured interviews with 12 subjects except

for one subject whose code is B-7 in Table 2 using the three-answer selection method—YES/NO/Neither—for the 13 questions to carry out a subjective evaluation. The ICF questionnaire was administered at an interview with subjects (A–L in the ICF-ID column in Table 2) after the social intervention. Two points were assigned to a "YES" response, and zero points were assigned to the "Neither" and "NO" responses. Using the sum of points for the 13 questions, we can analyze the performance of activity and participation quantitatively. ICF point totals for individual questions by subject are shown in Table 7.

Table 6. The narrative contents of these 13 questions

| Classification | No. | Questions | Yes (%) |
|---|---|---|---|
| (1) Learning and applying knowledge | 1 | Did you practice measurement of driving MONPAL actively? | 83.3 |
| | 2 | Did you undertake very enthusiastically tasks, or come to carry out tasks after using MONPAL? | 41.7 |
| (2) General tasks and demands | 3 | Did you come to more easily carry out tasks such as daily routine after using MONPAL? | 33.3 |
| | 4 | Did you carry out new daily routine after using MONPAL? | 50.0 |
| (3) Communication | 5 | Did you increase opportunities of communication with family, friends, neighbors, etc. after using MONPAL? | 83.3 |
| (4) Mobility | 6 | Did you increase the frequency of going out or moving your body after using MONPAL? Did you increase going to places you had never been after using MONPAL? | 50.0 |
| (5) Self-care | 7 | Did you come to more easily venture out to the neighborhood such as hospital after using MONPAL? | 50.0 |
| (6) Domestic life | 8 | Where you charged with household errands after using MONPAL? | 25.0 |
| (7) Interpersonal interaction & relationship | 9 | Did you make new associations after using MONPAL? | 41.7 |
| | 10 | Did your family bonds deepen after using MONPAL? | 25.0 |
| (8) Major life area | 11 | Did you get work anything after using MONPAL? | 10.0 |
| (9) Community, social & civic life | 12 | Did you play a more active social role after using MONPAL? | 16.7 |
| | 13 | Did you increase enjoyment of recreation and leisure after using MONPAL? | 16.7 |

We note below some interesting results on the subjective QOL evaluation by ICF and the relationship between the ICF and SF-36 scores.

1) QOL in functioning of "activities" such as (1), (3), (4), and (5) improved considerably; however, there was no QOL improvement in "participations," which involve higher-order functioning such as (8) major life area and (9) community, social, and civic life.
2) A major improvement in QOL for subjects I and E can be seen. On the other hand,

there was little improvement in QOL for subjects C, F, G, and L. Almost all of them stated, "I drive MONPAL inside of the special nursing home and care staff".

3) The average of total points for the four subjects who stated, "I cannot ride freely by myself" was 5.0 points. By comparison, the average for the eight subjects who stated, "I can freely ride by myself" was 13.3 points. The t-test found a statistically significant difference on average at the 5% level. Therefore, we can expect a greater improvement in QOL if the individual is able to operate MONPAL by herself/himself and if the environment allows her/him to move around freely.
4) There was no correlation between the ICF and FS-36 scores similar to that between LSA and SF-36 scores.

Table 7. Score of ICF activity and participation dimensions

| Classification | (1) | | (2) | | (3) | (4) | (5) | (6) | (7) | | (8) | (9) | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. / ICF id | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | |
| A | 2 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 10 |
| B | 2 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 16 |
| C | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| D | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 16 |
| E | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 2 | 2 | 0 | 2 | 2 | 20 |
| F | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| G | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| H | 2 | 2 | 0 | 0 | 2 | 2 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 12 |
| I | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 24 |
| J | 2 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| K | 2 | 2 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 12 |
| L | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| Total | 20 | 10 | 8 | 12 | 20 | 12 | 12 | 6 | 10 | 6 | 2 | 4 | 4 | |

## 6. CONCLUSIONS

We can draw the following conclusions from this study.

1) Improvement in QOL solely in terms of ICF activity and participation does not by itself improve comprehensive QOL, which is an important issue that should be pursued in the future through theoretical and empirical study. On the other hand, it does improve the level of mobility for subjects.
2) We should investigate the value that MONPAL increases the number of functioning such that we can move anywhere and we achieve any purpose from the viewpoint of the Quality of Mobility.
3) We have been holding an interview over and over again with subjects in these three social intervention fields for performance which MONPAL itself and surroundings should achieve.

There appear to be three main barriers that must be overcome to enable the elderly to use MONPAL as a transportation device in their daily life.

1) Psychological barrier: people do not want to look so weak that they can no longer walk by themselves.
2) Environmental barrier: the infrastructure and environment such as the road surface and running space in facilities are not suitable for MONPAL operation.
3) Operational barrier: the performance and standard of MONPAL are not sufficiently

user-friendly.

4) At the same time, we find sufficient evidence that MONPAL can become a safe and secure means of transportation to help maintain the QOL of the elderly.

Over the next 10 years in Japan, dramatic changes in population structure and prevalent illness type will occur. The next stage of the Japanese national health promotion policy, starting in 2013, switches its emphasis from improvement of "individual health performance" to the improvement of quality of "individual behavioral transfiguration" and the "realization of a good social environment". Regional infrastructure is indispensable to elderly people's health care. The creation of mechanisms and an environment that do not isolate elderly people indoors and that rebuild a local social community is necessary. Securing the elderly's QOL will likely be an urgent need in order to maintain the social security system. Thus, the development of specialized transportation devices with which elderly people can continue to carry out some activities and participate in social activities is of great importance.

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