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The Digital Book Design from a point of View of the Universal Design

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Abstract: The average life expectancy extends, independence spiritual not only physically has also become important for the elderly. E-books can be easily adapted for increased visual acuity in the elderly by adjusting the brightness of the font size, font, spacing, screen, etc. In the future, more effort should be applied to improving the applications of E-books for more than just the average person who likes to read. Considering the needs of the elderly in the continued design of the E-book, will greatly add to the value of this device. E-books can make reading more enjoyable for the elderly if they can take advantage of digital device reading. However, the needs of the elderly are not met sufficiently in the existing E-book. This study proposes a design for the E-book that the elderly can easily use and clarifies the elements that affect operability. It is hoped that designing the E-book in consideration for the elderly and further development of the E-book market will lead to an increase in the elderly population taking advantage of this digital device.

Keywords: Elderly people, E-book, Interface Design, Universal Design

1. Introduction

The issue of the elderly is advancing in Japan. The average life expectancy has increased. Spiritual as well as physical independence has become very important for the elderly. Daily leisure activities are needed to feel purposeful in life. According to a countrywide survey, more than 50% of elderly feel more purposeful when absorbed in activities. One of the hobbies that the elderly are doing specifically is reading. However, the amount of reading has decreased due to physical decline, loss of vision due to aging, and the increasing popularity of new hobbies and entertainment. With the spread of smartphones and tablets, the E-book market is expanding. E-books can be easily adapted for increased visual acuity in the elderly by adjusting the brightness of the font size, font, spacing, screen, etc. However, it is hard to say if the current E-book meets the needs of senior citizens considering there are preferences for both hard and soft surfaces. In this research, we focus on the reading behavior of the elderly with regard to E-books and reveal

what elements affect usability.

2. E-book use of the elderly

The E-book market has progressed rapidly and has been attracting attention. There are many benefits for the elderly. The small characters in books and the like contribute to the decline in eyesight in the elderly. With E-books, it is possible to adjust the size of characters freely. It is also possible to change the brightness of the line spacing font, margins, and the screen; it is possible to optimize their readability. In addition, it is assumed for E-book-only reader, are specializing in one function called “read a book,” and there is no complexity, pick up willingly in the elderly are not familiar with digital device. In addition, the accessibility of the E-book is ideal for those with limited mobility. The elderly who are unable to go to the library or bookstore can purchase E-books can while at home. However, the number of people who are using it actually is small at present. If you look at the E-book utilization by age, utilization of this resource is highest among those in the 20-year range. As age increases, the utilization of E-books actually decreases (Figure 3-10).

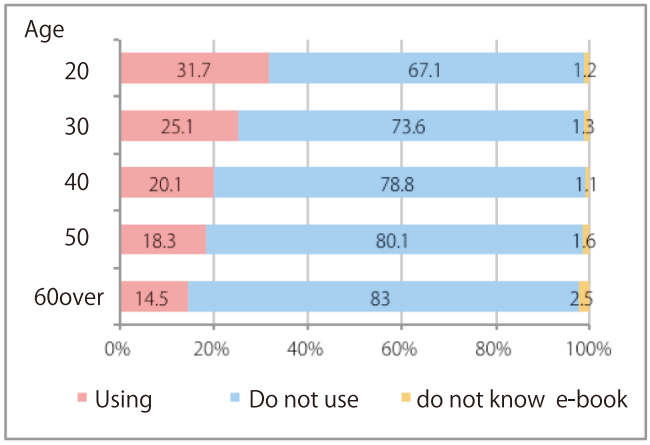


Figure1: By age E-book utilization

We can conclude that while there is widespread use of this device among young people, it is still a neglected activity among the elderly. In fact, the E-book as it stands currently is not fully meeting the needs of senior citizens whose preference fluctuates between books with hard and soft surfaces. In the future, more effort should be applied to improving the applications of E-books for more than just the average person who likes to read. Considering the needs of the elderly in the continued design of the E-book, will greatly add to the value of this device.

3. Awareness survey of E-book and the use of ICT for the elderly

3.1. Research plan

In order to understand the awareness of E-books and the use of ICT in the elderly, we conducted a questionnaire survey. By performing an impression evaluation of existing E-book readers, the analysis revealed opinions of the overall operation of the E-book. Further, a behavioral analysis was performed to characterize the actions of the elderly when reading E-books.

3.2. Survey on E-book and use of ICT(Information Communication Technology) for the elderly

In order to investigate the awareness of E-books and the status of ICT used to target the elderly, we conducted a questionnaire. The questionnaire was conducted in order to understand the current state of the relationship with ICT in the elderly population. We also investigated reading habits of the elderly.

3.2.1. Investigative method

1）Subjects: Twenty-eight university graduates (65 years of age or older)
2）Survey items: PC and Internet use, questions about the E-book

3.2.2. Survey results

There is experience with PCs and the Internet (Figure2) in about 90% or more of the participants in the investigation. The response “had used at work” was the highest (19 people). It is considered to be routinely utilized because 20 out of 28 people use it daily on the job. Using a terminal to access the Internet was most frequent (multiple answers allowed), with 28 people using a personal computer. Six people use smartphones and tablets in the experiments, and is higher than the rate of possession of the same age. People cite tablets, smartphones, and terminal use as something for the future and also show interest in newly developed devices.

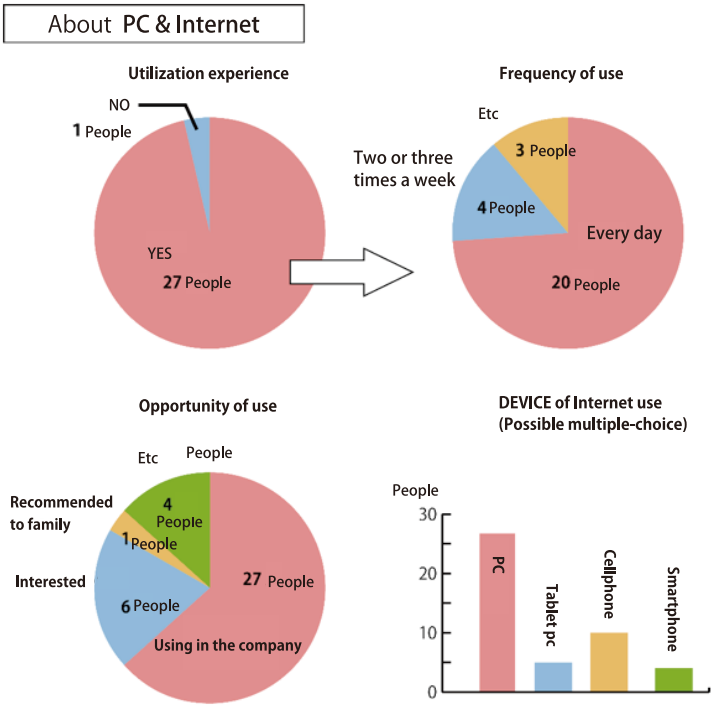


Figure2: Survey results on the PC & Internet

According to the survey results (Figure3), all respondents are aware of the E-book. However, 4 in 28 people actually use it. Personal computer, tablet, smart phone has been mentioned terminal utilizing the E-book. When asked the reason they do not use E-books, the answers obtained were “I like paper books” (17 people) and “seems Unreadable E-books“ (7 people).

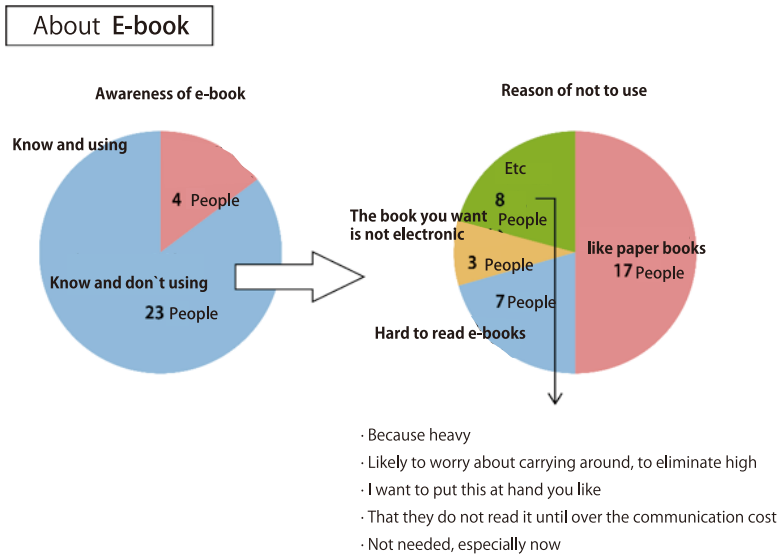


Figure3: Survey on E-book

When asked about everyday reading habits (Figure4), 13 people answered that they read 2-3 books in one month, and 7 answered that they read 1 book per month. From this, we have determined that older people engage in a certain amount of reading in many cases. When asked about where they read, 12 people answered, “Train or Bus” and 1 person answered, “My room.” We can conclude that most people combine reading and travel time.

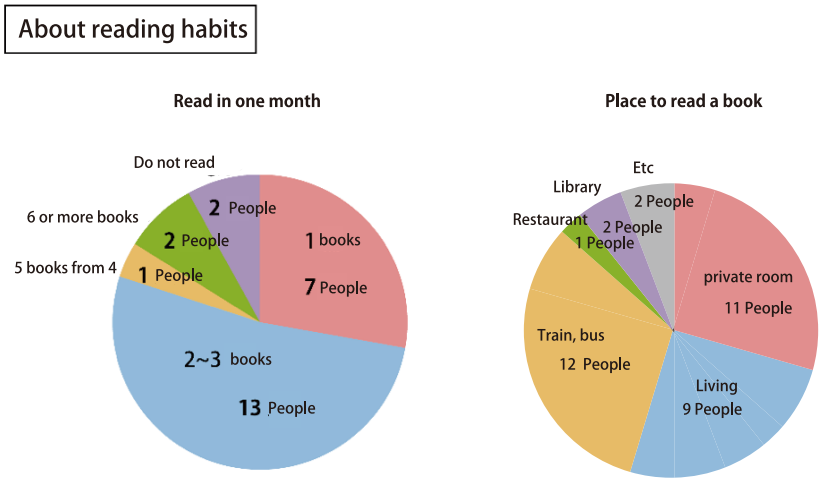


Figure4: Questionnaire results on the reading habits

3.2.3 Summary of survey results

From the above results, it is evident that many older people are familiar with the personal computer due to computer usage in the workplace. The number of people who use smartphones and tablets is not significant, but the responses indicate a desire to use them in the future. All respondents are familiar with E-books; however, the number of people in this population who use the devices is relatively small. We considered the convenience of E-book is not well understood, and the attachment to paper books is due to the preconception that it is more difficult to use the

E-books. In the questionnaire regarding reading habits, 24 out of 28 people responded that they found the following review helpful (two people did not respond). The results do show that that the elderly enjoy reading as a habit.

4. Impression evaluation experiment of E-book reader

We performed the experiment to investigate the impressions of the elderly population regarding the ease of use of the E-book reader.

4.1. Experimental method

1)Subjects：68 years to 79 years of age（7 males）

2)Experiment content : The questionnaire on the E-book reader evaluates the respondents' impressions in five stages. We selected these based on the "telecommunications accessibility guidelines in consideration for elderly persons and persons with disabilities, etc." The evaluation items used were three models of Kindle E-book reader top selling (Amazon), Kobo (Rakuten) Reader, and (SONY).

3)Use of equipment : The figure below shows the details of the E-book reader that was used in the experiment.

Table1: List of E-book readers

Model	photo	size	display size	weight	location of power	Aspect ratio
Kindle Paperwhite (Amazon)		169 x 117 x 9.1mm	6 inch	213g	 Lower body	1 : 1.44
Reader (SONY)		110 x 173.3 x 10mm	6 inch	164g	 Lower body	1 : 1.58
Kobo (楽天)		114 x 157 x 10mm	6 inch	185g	 Upper body	1 : 1.38

4)Property of the subjects: the figure below the attributes of the subject.

Table2: Attributes of the subject

subject	sex	age	job	Experience of PC use	Frequency of PC use	Period of PC use
A	male	68	Unemployed	yes	2-3 times / week	2-5 years
B	male	77	Unemployed	yes	2-3 times / week	Over ten years
C	male	79	Unemployed	yes	Every day	Over ten years
D	male	66	Unemployed	yes	Every day	Over ten years
E	male	72	Company employee	yes	Every day	5 -10 years
F	male	69	Unemployed	yes	2-3 times / week	5 -10 years
G	male	68	Unemployed	yes	Every day	Over ten years

4.2. Result

For operation of the three models of E-book reader, I asked the subjects to evaluate the impression in five steps. The outcome measures were set as the following characteristics: easy to hold or difficult to hold / light / heavy, large / small, easy to push it or hard to push / easy to understand or confusing / safety / risk, the seven items of one hand / both hands. Questions were asked regarding activating the power button—easy to push or hard to push— and if one or both hands were used. The graph shows average score PC frequency of use for each item and PC use life for each device (Figure5).

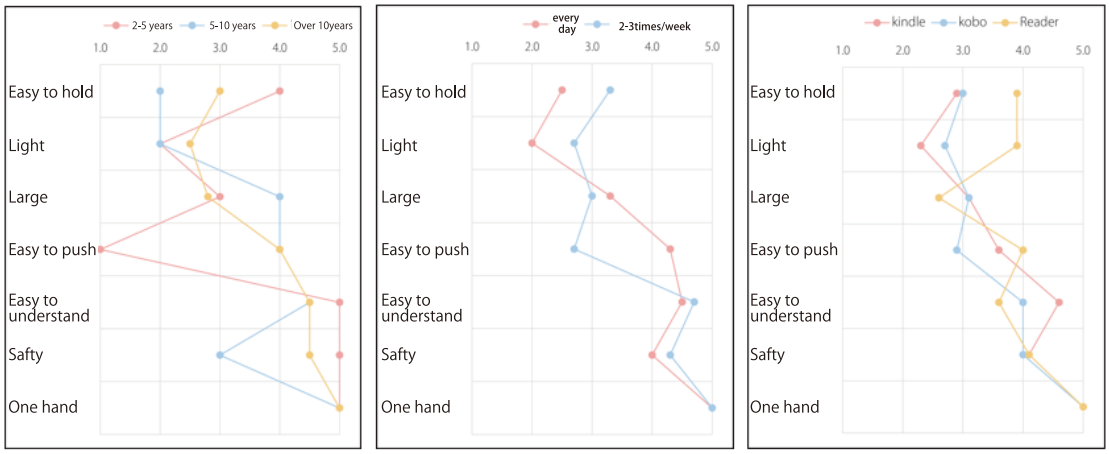


Figure5: The average score of the impression evaluation

●Analysis of variance

Frequency of PC use and the number of years for each device were subjected to analysis of variance to verify significant differences obtained. As a result, “PC frequency of use - easy to push,” “PC use the number of years - Safety” and - significant difference was observed in the “Device light” ($p < 0.05$). The items covering use by one or both hand were evaluated by the same score and were excluded from the analysis.

Table3: Results of analysis of variance

	Frequency of PC use	Period of PC use	Device
Easy to hold	n.s.	n.s.	n.s.
Light	n.s.	n.s.	p<0.05
Large	n.s.	n.s.	n.s.
Easy to push	p<0.05	n.s.	n.s.
Easy to understand	n.s.	n.s.	n.s.
Safty	n.s.	p<0.05	n.s.

1）”Easy to push” and “PC usage frequency”

We concluded that there is a tendency among people who have infrequent PC (or other digital equipment) usage to find the operation of E-books more difficult and to have problems turning the power off and on. Conversely, people who utilize a PC more frequently stated that the power button was “easy to push.”

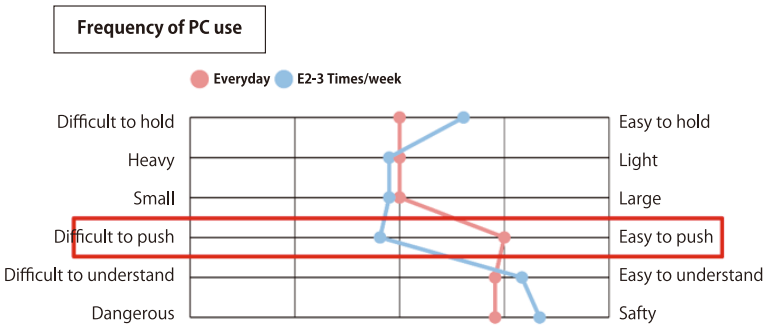


Figure6: Easy to push - PC usage frequency

2）"PC use the number of years" and "safety"

We considered that confidence in the safety of digital equipment is dependent upon length of experience; beginners attach greater importance to safety.

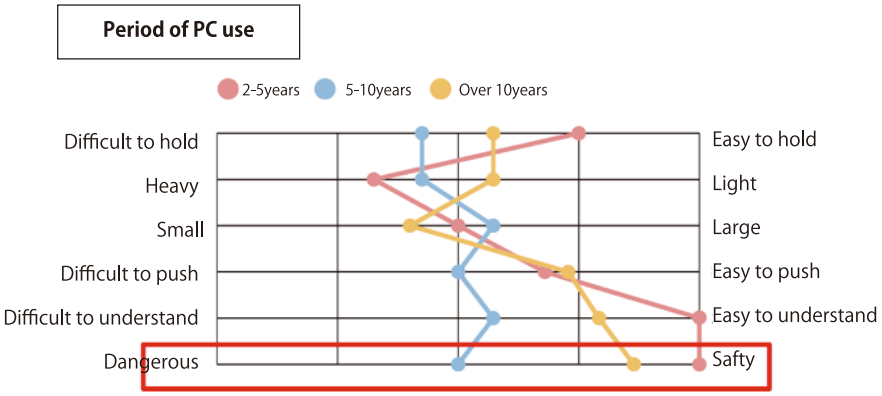


Figure7: PC use life - Safety

3）Device weight

For the weight of the device was found to greatly affect the perception of the usability when there is even a slight difference in weight. The weight of the Reader and the Kindle is a difference of about 50g, but this made a major difference on the evaluation. In other words, weight is a significant factor regarding usability for this population.

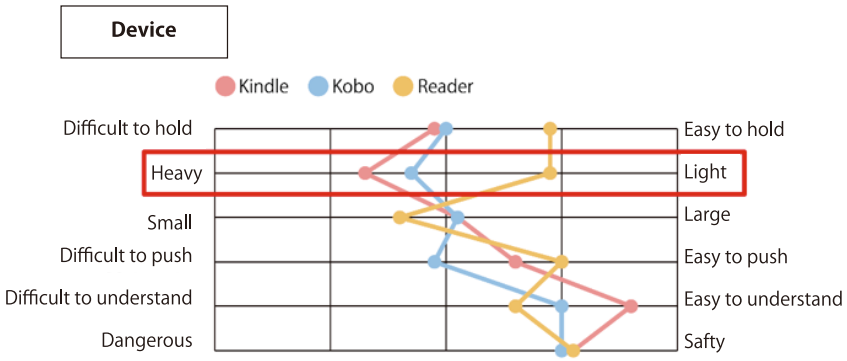


Figure8: Device - Light

・Principal component analysis

The overall operation of the E-book reader was subjected to principal component analysis. As a result, the main component of the two was obtained.

Table4: Result of principal component analysis

	The first principal component	The second principal component
Easy to hold	0.547	-0.102
Light	0.411	-0.376
Large	-0.503	0.134
Easy to push	0.230	0.059
Easy to understand	0.065	0.789
Safty	0.471	0.451

The first principal component included the following characteristics: “easy to hold,” “light,” “large,” and “operation of the hardware surface” of the E-book. The second principal component represents the “clarity of the software surface.” It was found that the hardware and software are not easy to understand in the operation of the E-book reader. In order to improve operability, it is necessary to consider both hardware and software.

5. Behavior observation experiment

The objective was to observe the characteristics of the actions of the elderly in operating the E-book.

5.1. Method

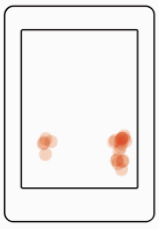
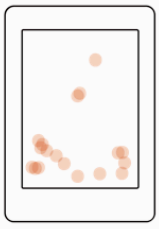
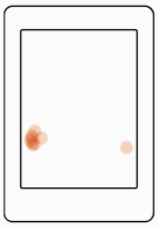
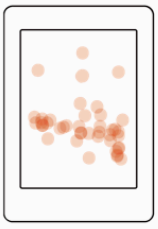
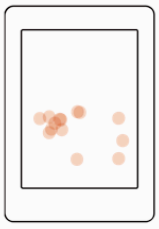
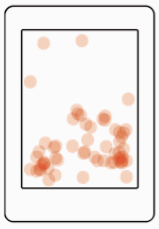
1) Subjects：68 years to 79 years（6 males）

2) Experiment content： We utilized a video camera to observe how the subject operated an E-book reader (kindle) without instruction.

5.2. Result

We used a video camera to observe how the subject operates an electronic book. We have summarized in the following table and record of action, the distribution map of the screen t ap position.

Table5: Record table of behavior observation

subject	A	B	C	D	E	F
age	77	68	79	72	69	68
sex	male	male	male	male	male	male
frequency of use pc	2-3 times/week	2-3 times/week	every day	every day	2-3 times/week	every day
period of pc use	over 10 years	2-5 years	over 10 years	5-10 years	5-10 years	over 10 years
position of the tapping						
used hand	Right hand	Right hand	Right hand	Right hand	Right hand	Right hand
Finger	Index finger	Index finger,Middle finger	Index finger	Thumb, Index finger	Index finger	Index finger,Middle finger
How to hold	左手で持つ 背面全体を覆う	左手で持つ 右手を添える	テーブルに完全に置く 左手を添える	左手で持つ 背面全体を覆う	左手で持つ 背面全体を覆う	左手で持つ 背面全体を覆う
Table	×	△	○	×	×	×
Menu	×	×	×	×	×	○

5.3 Discussion

Regarding the soft surface of the E-book, the elderly are not familiar with the touch panel operation or the “pinch out to enlarge” function. The menu screen that requires a tap and swipe motion to activate the screen was also elusive for the subject. While it may be natural for younger people who are familiar with these functions, the actions are not understood by the elderly. It was difficult for the subject to hold the device as well because of the hard uneven surface with no depth to the device. In addition, we found that two elements of hardware and software affect the operability of the analysis results. In order to improve operability, it is necessary to satisfy both elements. From the research results, we have determined that incorporating the behavior of real paper books with the technology of an E-book would make a real difference as regards usability for this population. We propose that the interface of an E-book should have a page turning function similar to that of actually turning pages when reading paper books and other print media.

6. Conclusion

It is important for the elderly to maintain active lives in order to have a purpose in life. E-books can make reading more enjoyable for the elderly if they can take advantage of digital device reading. However, the needs of the elderly are not met sufficiently in the existing E-book. This study proposes a design for the E-book that the elderly can easily use and clarifies the elements that affect operability. In order to understand the status of ICT use and the awareness of E-books in the elderly, we conducted a questionnaire survey. As a result, we found there is a significant amount of the personal computer experience among many older people, especially for use of at work. However, although the awareness of E-books is high, usage is minimal due to an attachment to paper books. The perception is that it is difficult to use E-books. Next, we investigated the impressions of the elderly using an impression evaluation experiment. The results of the analysis show that in order to improve operability, it is necessary to consider changes in both hardware and software. The weight of the device has a major influence on the perception of ease of use for the device. Further, it is easy to use regardless of the difference in the experience with ICT device is also important. The behavior experiments conducted in order to clarify the characteristics of the behavior of the elderly have shown that the elderly attempt to read electronic books in the same manner they would read a paper book. The result is uncomfortable because they cannot read the E-book as smoothly as a paper book; the touch screen is still something they are not familiar with.
From the above experimental results, as an important element in operability, (1) easy to use for both hardware and software, (2) easy to use regardless of the difference in use experience and (3) gap between paper books is less. It is hoped that designing the E-book in consideration for the elderly and further development of the E-book market will lead to an increase in the elderly population taking advantage of this digital device.

REFERENCES

TAKIGUCHI Yusuke, ISONO Haruo, YAMADA Chihiko(2006)：Study of the Usability of e-books for the Aged and Young Reader. EID, EID, 105(617), 13-16

AKATSU Hiroko, HARADA Etsuko T., MIKI Hiroyuki, KOMATSUBARA Akinori(2011)：Design Principles for IT Equipment Based on Cognitive Behavioral Characteristics of Elderly Users : Usability Test Applied to Automatic Teller Machines (ATMs), Jpn Ind Manage Assoc 61(6), 303-312

総務省(2012)：平成 24 年通信利用動向調 http://www.soumu.go.jp/johotsusintokei/statistics/statistics05a.html

総務省(2013)：情報通信白書平成 25 年度版, http://www.soumu.go.jp/johotsusintokei/whitepaper/

鈴木隆雄他(2006)：日本人高齢者における身体機能の縦断的・横断的変化に関する研究，厚生の指標, Vol53, No.4, pp.1-10

総務省：ICT 超高齢社会構想会議報告書, http://www.soumu.go.jp/main_content/000226641.pdf

内閣府(2012)：平成 24 年度高齢者の健康に関する意識調査, http://www8.cao.go.jp/kourei/ishiki/h24/sougou/gaiyo/ index.html

総務省(2012)：スマートフォン及びタブレット PC の利用に関する実態及び意向に関する調査研究, http://www.soumu.go.jp/johotsusintokei/linkdata/h24_07_houkoku.pdf

内閣府(2009)：高齢者の地域社会への参加に関する意識調査, http://www8.cao.go.jp/kourei/ishiki/h20/sougou/zentai/

内閣府(2012)：平成 23 年度社会生活基本調査, http://www.stat.go.jp/data/shakai/2011/index2.htm#kekka

楽天リサーチ,Kobo Inc.：シニアの読書に関する調査, http://research.rakuten.co.jp/report/20130830/