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SMART HOME

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Guide to needs, problems, interests and solutions in the own home for people with Down syndrome - Bonus: Extended Version -

Project number: 2021-1-DE02-KA220-VET-000033058

Partners

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1. Introduction

This 'Guide to the needs, problems, interests and solutions in the own home for people with Down syndrome' was developed as part of the SWEET HOME project. SWEET HOME is an ERASMUS+ funded project carried out by 6 organisations from 5 different countries (Germany, Spain, Italy, Greece and Belgium). The project runs from February 2022 until August 2024.

The aim of the project is to enable people with different types of disabilities to live a more comfortable, independent and self-determined life in their own homes. This is to be achieved through the use of smart technologies. The ultimate objective is to find suitable and affordable technological solutions for people with different kinds of disabilities and develop free online learning courses for persons with disabilities themselves, their support persons and professionals who work with them. These learning courses should educate the aforementioned target groups on the different types of smart home technologies available, and how to program and use them.

In order to achieve this goal, Sweet Home carried out a study to get insight in the needs, interests, challenges and solutions in the own home for persons with disabilities. This report summarises the results of this study for persons with Down syndrome, which is one of the focus groups of the SWEET HOME project, alongside persons with Alzheimer, visual impairment, hearing impairment, muscular dystrophy, cystic fibrosis and renal disease.

What is Down syndrome?

Down syndrome is a genetic condition that influences development throughout life. It is one of the most common causes of intellectual disability.

It is estimated that around 250,000 babies are born with Down syndrome worldwide each year. However, it is not clear what is the exact number of people living with Down Syndrome worldwide, as accurate data collection can be difficult and varies by country. It is caused by the presence of an extra copy of chromosome 21, which leads to delays in physical and mental development, as well as a distinct set of physical characteristics. For that reason, the medical term "Trisomy 21" is also used.

The physical characteristics of Down syndrome can vary widely among individuals, but there are some common features that are commonly associated with the condition. Some of the

most common physical characteristics of Down syndrome include a flat facial profile, with a small head and short stature. Other common physical features include an upward slant to the eyes, short fingers and hands, small ears, low muscle tone, a protruding tongue and a single crease across the centre of the palm. It's important to note that not all individuals with Down syndrome will have all of these physical characteristics, and the degree of severity can vary. Additionally, these characteristics may not be as obvious in older individuals with Down syndrome.

People with Down syndrome may also experience intellectual and developmental delays which can affect their cognitive abilities and learning. Some of the common intellectual characteristics of Down syndrome could include delays in learning to walk, talk, and perform daily tasks. They may also have difficulty with memory, attention, and problem-solving. Also, persons with Down syndrome on average score lower on IQ tests compared to the general population, they may have difficulty with abstract reasoning and understanding concepts, with fine motor skills and coordination and with understanding social cues and social interactions. However, the degree of intellectual disability can vary widely among individuals with Down syndrome, and some may have IQ scores in the range of typical development.

Despite these challenges, with the appropriate education, therapy, and support, many persons with down syndrome are able to hold jobs and live (partly) independently. A smart home can also be a valuable tool for people with Down syndrome, as it can improve their level of independence, it can increase safety and foster communication.

Improved medical care in developed countries is now helping people with Down syndrome to live longer, even beyond 60 years - up from only 30 years in the 1970s. It's important to remember that Down syndrome is not a disease and cannot be cured. With early intervention, education and appropriate medical care, many of the developmental delays and health concerns associated with Down syndrome can be mitigated.

It is also important to recognise that people with Down syndrome are unique individuals, with their own strengths and weaknesses, just like anyone else. In this report, we try to make some general observations and conclusions, but one should be aware that not everything can be applied to a specific individual person.

Outline of the report

Chapter 2 of this report will outline what methodology has been used to carry out the analysis, including a description of the interviewees, carried out home observations and participants in the expert roundtable.

Chapter 3 summarises the findings, following the structure of 10 different topics (healthcare and monitoring, personal care, home comfort, home security, entertainment, cleaning, home mobility, energy saving, social participation and e-learning). For each of the topics, interests, needs and challenges will be discussed on the one hand, and solutions and recommendations on the other hand.

Finally, Chapter 4 includes further recommendations for the industry and policy makers.

Disclaimer

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

2. Methodology

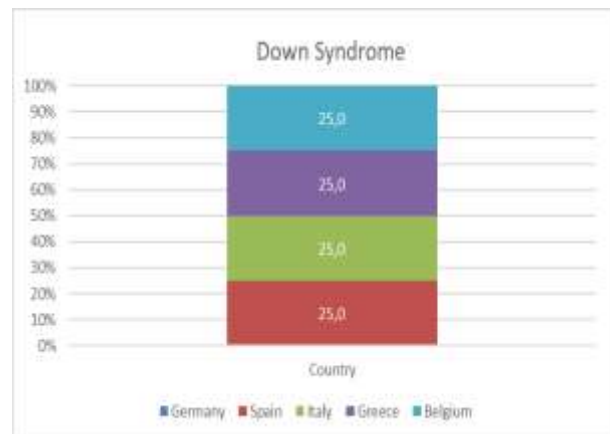
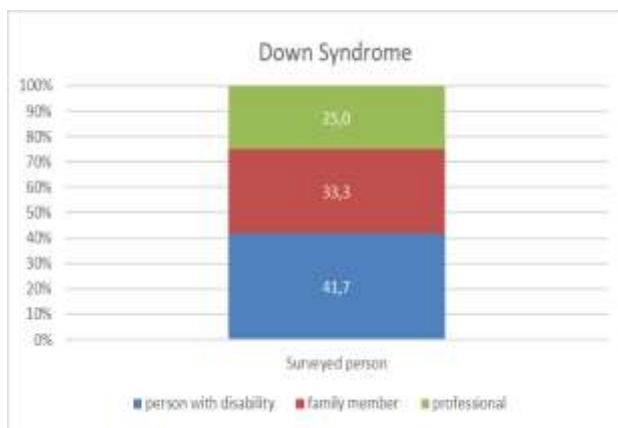
This study is based on 12 completed questionnaires, 12 interviews, 3 home observations and an expert roundtable with 10 participants. It was completed by some desk research. Due to the low number of questionnaires, interviews and home observations, this report is not meant to give an encompassing and representative overview of the needs and challenges of persons with Down syndrome, but is meant to point out some insights and examples; and also it could not be applied to a particular case.

Questionnaires and Interviews

The respondents taking part in the questionnaires and interviews were five persons with Down syndrome, four family members of persons with Down syndrome, and three professionals working with them. The questionnaires and interviews contained questions to identify challenges, interests, and opportunities, based on self-assessment for the persons

with Down syndrome and external assessment for family members and professionals. They also contained questions about the person's IT skills and familiarity and interest in smart home solutions and future learning materials of the SWEET HOME project.

The respondents came from Spain, Italy, Greece and Belgium. The number of men and women who participated is gender balanced, with 7 responses coming from women and 5 from men. Most respondents indicated they, or their family member or person they support, live in a small town (66.7%), where others indicated that they live in a big city (16.7%) or in the countryside / isolated house (16.7%). Most respondents indicated that they live in a house (66.7%) whereas others indicated they live in an apartment/flat (16.7%) or assisted



living facility.

Figure 1: Group of people who have answered

Figure 2: In which country does the survey take place

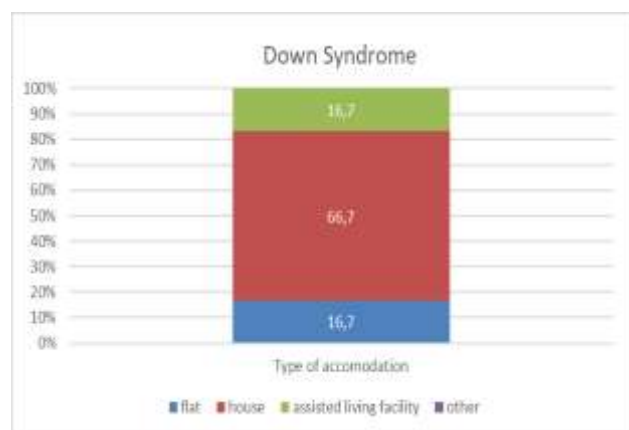
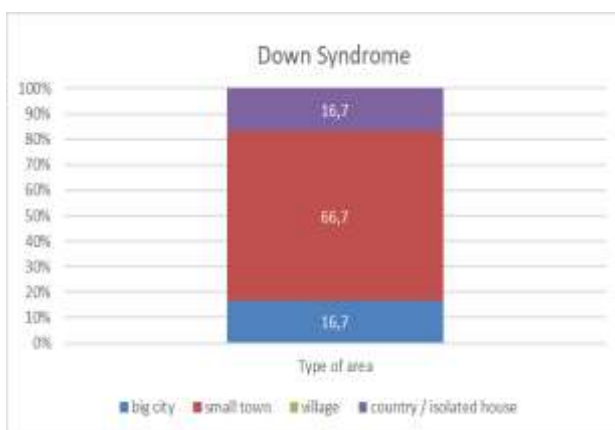


Figure 3: What type of area do/does the person you care for you live in?

Figure 4: Where do you/does the person you care for live?

Home Observations

Three home observations were conducted in Belgium, Italy and Spain. The observations were carried out in the place where the person with Down syndrome lives (whether it is an institution, a family or their own home), observing the persons who also participated in the interview and analysing their previous answers. The observer could choose one out of three methods to carry out the observation: 1) by following the structure of everyday routines (observing the person throughout the day); 2) according to the spatial and functional layout of the living space (while making a tour through the house the person shows how they live their daily life); 3) by going over the ten topics of the project. Following the home observation, the observer filled out a log sheet summarising the challenges and needs, the solutions already in place, and how unmet needs could be addressed by technological solutions.

Expert Roundtable

During the Expert Roundtable, the preliminary findings of the study were shared with 10 experts, who could give their expert view on the needs, interests, challenges and solutions when it comes to the use of smart solutions in the home for persons with Down syndrome. The experts included 2 experts in Domotics, Ambient Assisted Living and Home automation (one with no previous engagement with the project and one that has), one interior designer, one professional who works with people with down syndrome (he is teacher, guidance counsellor and former director of a special education school and in addition, member of Association of People with Intellectual Disabilities), a psychologist, a person with Down syndrome, and a family member (his brother), and finally an interpreter to help in communication. It was done face to face in Spain with the presence of 2 persons online.



Image 1: Picture of the round table about Down syndrome

Image 2: Picture of the round table about Down syndrome

3. Findings

Different challenges for persons with Down syndrome to be independent in their homes were identified. For example, they often need help from others in several activities like cooking, personal hygiene or making coffee because of difficulties with fine motor skills. In addition, they have problems with personal healthcare, using technology or managing money. They may have cognitive or memory limitations which makes it challenging to understand some concepts or to make plans to perform activities with different sequential tasks. It is important to focus on their safety because it is one of the main concerns of the family and professionals. They are for example afraid about their security when they are using items in the kitchen or with the possibility of receiving visits from strangers. Also, they sometimes have problems with the communication with others, as sometimes other people don't understand them. As a consequence, it could be difficult to form relationships with others and they could lose the contact with the community.

It could happen that it will be difficult for persons with Down syndrome to follow some instructions without a previous example. For example, during the interviews it came up that when the person cannot read, it is needed to use very clear instructions on how to use technology, sometimes with images or explanatory videos. It is important to make them understand concepts with practical and meaningful examples with concrete steps.

Some of the people with down syndrome in the research are already using smartphones or technical devices, mainly for entertainment or communication. Families are worried that they will not be able to call for help if it is needed or in case of emergency, and therefore emphasised that this should be easy, fast and effective.

There were some cases where the person did not know how to control the temperature in the house without the support of another family member because the system to control this could be difficult.

Another encountered problem was about healthcare: sometimes they could forget to take a pill or a medicine on time, forget to monitor other aspects like the blood pressure, they could have problems to follow a diet program and control the food, or to control the intake of water.

It should be mentioned that a lot of variability in the abilities of people with Down syndrome has been found in all steps of the research, from people who had a high degree of autonomy to people who needed more support. In some cases overprotection by the environment can prevent persons with Down syndrome from doing more activities. This is important because some people, with appropriate technology and confidence, could carry out more tasks independently and could try to control some technologies by themselves.

There are several smart solutions available that can help persons with Down syndrome to face those challenges, solve their needs and help them in daily tasks in order to achieve to live more independently and be more self-determined, such as smart voice assistants, smart blood pressure monitors, medication reminders, smart automatic doors and shutters, ambient sensors, cooking robots, cleaning robots, smart plugs and even motion sensors can help to monitor the person’s behaviour from a distance. Also it is possible to use learning apps with easy steps or simple smart TVs with remote controllers with big buttons.

When it comes to the use of smart home technologies, a challenge with this target group is that in some cases it is difficult to learn about the different steps to use it and they could lose some of the functionalities because of that or in the most difficult cases they could totally leave after a while because of demotivation. However, we also encountered cases where people with down syndrome were totally capable to use some smart home devices. Another problem is to install the technology or configure it according to the personal needs, or solve problems when the technology is not working. Most part of the respondents to the questionnaire (80%) valued their experience as ‘no experience’ or ‘beginner’ in IT skills. For that it is important, for this groups, that the smart home solutions should be very user-friendly and intuitive. In some cases, simplified devices can therefore be useful for them.



Figure 5: How would you rate your level of IT skills (internet, computer, smartphone)?

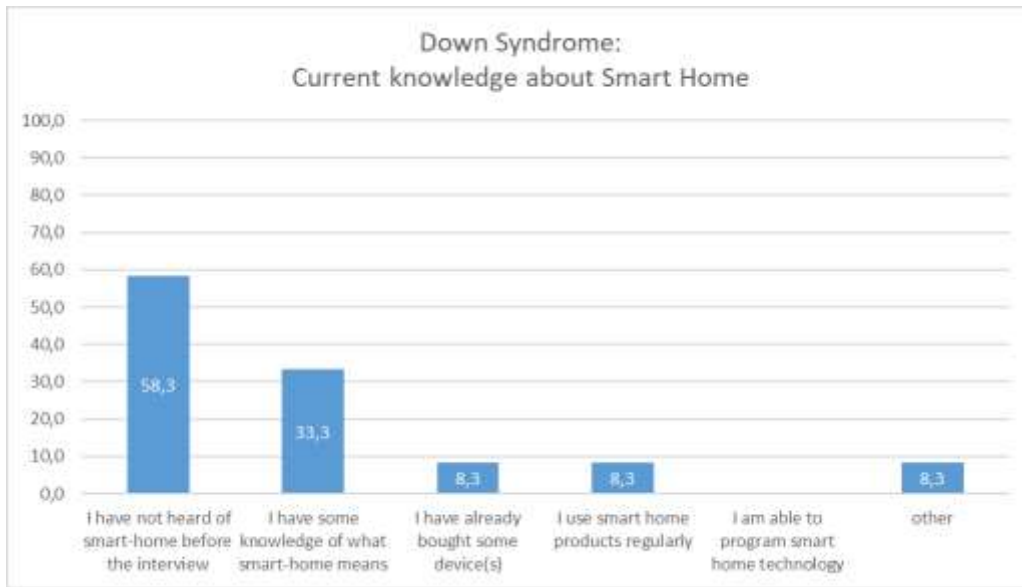


Figure 6: What is your current knowledge on smart-home devices?

3.1 Healthcare and Monitoring Interests, needs and challenges

The completed questionnaires, interviews, observations and round table show that healthcare and monitoring is one of the most important topics for this target group. 58,3 % found ‘devices for health (e.g. body measurements and fall alarm)’ most useful. In some cases, participants indicated that the person with Down syndrome does not know how to monitor important medical aspects such as blood pressure on a daily basis and this could be a big problem. We have to take into account that a person with Down syndrome is at increased risk of certain heart defects.

It is also especially important for this target group to have a good nutrition: having a balanced diet with fruits, vegetables, lean proteins, and whole grains to manage weight and in order to prevent other health problems related with gastrointestinal issues, such as constipation and celiac disease. In some cases, it is needed to monitor this, including the amount of water that the person has drunk.

One critical issue is to take the correct medicine at the correct time and reminding to do so everyday, as well as remembering whether or not the medicine has been taken that day already, or which medicine is the right one for which problem.

Some family members said that they are worried in the event of a fall or if some health problem suddenly appears.

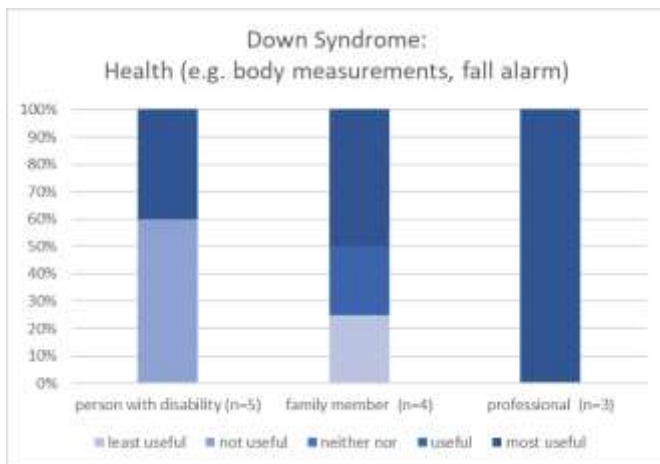


Figure 7: The most useful home devices – Health (e.g. body measurements, fall alarm)

Solutions and Recommendations

- There are some technologies, such as ECG devices, pulse oximeters or blood pressure monitors, which send the information in real time to doctors or medical services.
- There are many different solutions for meal planning. Most of them are based on apps to be used on smart devices (tablets, smartphones,...). In addition, there are apps to track what a person is eating, using AI techniques and image processing to recognise food and identify calories.
- There are smart solutions to monitor water consumption, most of them are based on an intelligent water dispenser able to obtain the quantity of water consumed daily or in certain moments.
- There are many different solutions on medication reminders. Not only apps-based solutions, but also pills or automatic medicine dispenser. The dispenser gives off an alert and releases the medication. There are several app lists for medication reminders which can suit a variety of needs (e.g. to encourage users to take medications on schedule and commit to daily healthy habits). Also, there are some who could answer questions about medications and provide personalised health tips.

- Smart refrigerator can scan items from inside, identify them and send updates when new or old items are out. It can be a solution to support identification and tracking of the diet that is following the user.
- Falling detectors or movement sensors who could give information or an alarm to caregivers.
- Smart voice assistant which could help to remind several things like schedules for medicine or buying some important products of the diet or some recipes.
- Smart scales: These devices use Bluetooth technology to track weight and send the data to a mobile app, allowing to monitor the weight and track progress over time.

3.2 Personal Care

Interests, needs and challenges

Problems with personal care appears in multiple responses of the interviews and questionnaire. Family members state that one of their main concerns is that their family member with Down syndrome is unable to take adequate care of themselves in many ways. This could be because of problems with fine motor skills, leading to difficulties with tasks such as buttoning clothes, tying shoelaces, brushing hair or even brushing teeth.

The problem of personal hygiene, in particular difficulties in washing and showering, has emerged multiple times. In some cases some individuals with Down syndrome may not have an understanding of personal hygiene and they may not be aware of the need to maintain personal hygiene, but in other cases the problem is that the different required steps to take a shower can be difficult for them.

Moreover, those with cognitive impairments may have more difficulty understanding and completing personal care tasks and may need extra support and guidance in some cases.

Solutions and Recommendations

- Simplified shower usage. The easy use of push buttons and clear labels inside the shower can allow individuals to adjust water temperature with ease and increased safety. Even there are sophisticated systems such as smart showers.

- Smart toothbrushes: These devices use sensors and Bluetooth technology to track brushing habits and provide feedback on how to improve oral hygiene.
- Smart voice assistants. Organisation of sequence of actions is very helpful for personal care actions, so any type of reminder and sequence provider can help people to their personal care tasks.
- Smart mirrors: These devices use a built-in camera and voice recognition to provide step-by-step instructions on how to perform personal hygiene tasks such as brushing teeth and washing the face.
- Smart showerheads: These devices can be controlled through a mobile app or voice commands and can be programmed to dispense a specific amount of water, track water usage, and automatically turn off when not in use.

3.3 Home Comfort

Interests, needs and challenges

When we look at the results of the survey, we see that home comfort is 'most important' or 'important' for almost all the respondents.

In the interviews and home observations, several issues related to home comfort were mentioned. Some problems were found with using the thermostat (deciding and applying a correct temperature in the house).

Also, problems with opening and closing shutters were identified, and switching on and off the lights. Moreover, due to possible cognitive limitations, it could be difficult for persons with Down syndrome to follow instructions for operating appliances and other home comfort systems, or to identify their own needs in home comfort in the first place.

Several respondents indicated they have difficulties with switching on the heater and switching on the lights, and some had difficulties with time orientation, or locating things inside the house.

One social worker indicated it would be helpful to receive an alert when the fridge is running out of food. Another respondent expressed interest in automatic opening of the front door of the apartment.

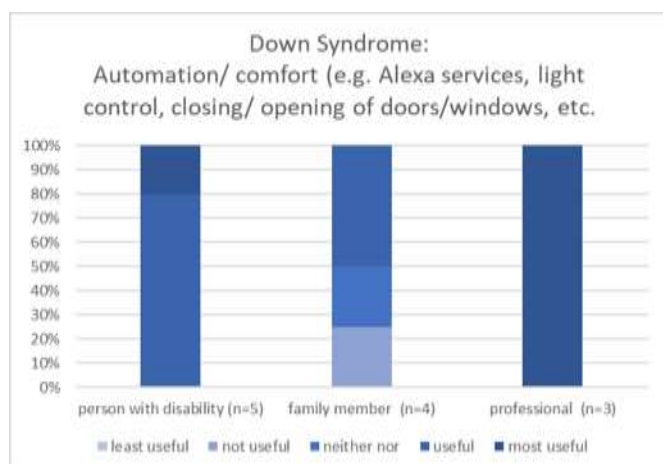


Figure 8: Most useful devices – Automation/comfort (e.g. Alexa services, light control, closing/opening of windows, etc)

Solutions and Recommendations

- Use of automatic lights (smart lights). There are different alternatives to control and automate the use of lights. Indoor motion sensors which can be used to switch on/off lights in specific rooms, or remote control of lights, are only some examples of light automation. People with Down syndrome, or even their relatives, can check and take control of lighting remotely if it is needed.
- Use of automatic shutters which could be programmed to open and close at specific times or in response to certain conditions, such as changes in temperature or light levels. Shutters can be used to control light and ventilation, provide security and privacy, and help to regulate temperature and energy usage
- Smart plugs allow the users to control any connected device (TV, washing machine, coffee makers, heaters, fans, HVAC, etc...). and they could activate/deactivate devices remotely, even caregivers can check the state of the device in real time; it is possible to program (schedule) the switching on/off of any device (for instance, switch on the washing machine or switch off TV at a certain time) and energy consumption can be monitored.
- Ambient sensors can be used to improve home comfort, for example weather stations can give useful information about the weather, including temperature, relative humidity, pressure, etc. This information can be used for triggering heating, ventilation and air conditioning (HVAC) functionalities. Some facilities implement ambient sensors that monitor variables such as CO₂, particulate matter, formaldehyde, VOC (volatile organic compounds), etc. This monitoring provides

useful information about the air quality, usually represented with the AQI (air quality index). There are many different plug & play solutions available on the market.

3.4 Home Security

Interests, needs and challenges

Devices related to home security are considered as most useful for almost all respondents, and safety is also a recurring theme in interviews and at the round table.

One of the main concerns of the family members is access to the home of unwanted visitors.

Another safety concern can be the limited awareness of potential hazards, such as open flames or while using some household appliances. The person with Down syndrome may not be able to recognise certain dangers, and it can happen that they do not know what to do in case of an emergency.

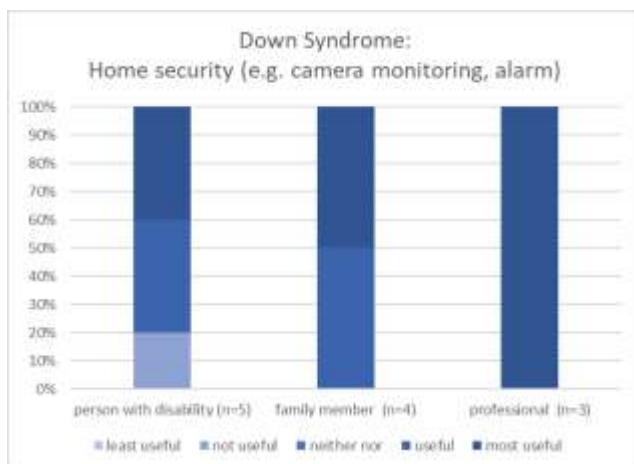


Figure 9: Home security (e.g. camera monitoring, alarm)

Solutions and Recommendations

- Smart door openers can be used in almost every house. A smart lock can be installed on the door, and can be opened securely with a Smartphone or with a code. Smart doors can also be controlled with voice commands, which can be especially helpful for people with Down syndrome who have difficulty with fine motor skills or who have difficulty understanding instructions. Some of those smart doors have automatic locking features, which can help ensure that the door is always locked when nobody is at home. It is possible to access with a code or a fingerprint scanner, which can be easier for people with Down syndrome as they won't have to use a key. Finally, the system could have a camera or intercom in order to see the person before opening

the door. The smart door can even identify visitors before allowing them entry, which can be especially helpful if the person has difficulties recognising people or distinguishing between strangers and friends. In order for this to function, a list of trusted visitors, such as family members and caretakers, needs to be created.

- Voice assistant can be very useful to remind some typical home security actions during the day. For example, check the closed door, verify the HVAC state, switch off a specific device, etc. Smart assistant can identify and show sequence of action to improve security at home.
- One of the most helpful products to avoid possible problems during cooking are the cooking robots. These devices indicate to the user the complete sequence of cooking and contribute to avoid possible boiling problems and switching off omission.
- There are many different alternatives to use ambient sensors for security purposes. For example: CO sensors are used to prevent carbon monoxide poisoning due to incomplete combustion of heaters; automatic electric fire alarms, water detectors that warn when floods occur.
- Security cameras: Install security cameras outside the house and in common areas, which can deter unwanted visitors and provide a record of who comes and goes.
- Install an alarm system which will be easy to operate, with simple buttons or controls that can be easily understood and used or with the possibility of being controlled with voice commands. A personal emergency response system (PERS) can be included, which is a wearable device that the individual with Down syndrome can press to call for help in case of an emergency.

3.5 Entertainment

Interests, needs and challenges

Entertainment at home is important for people with Down syndrome for several reasons including the mental stimulation that this could provide to them, and it could improve their emotional well-being reducing stress and anxiety, improving their sense of happiness. Even, some entertainment activities in the house could provide opportunities to have some physical activity or unleash their creativity. Entertainment can also be an opportunity to socialise with others.

To the question “the person with disability has access to various entertainment activities at home” most agreed or fully agreed, with only 2 respondents that neither disagreed nor agreed. And also, almost all respondents indicated that entertainment devices are among the most useful devices for people with Down syndrome.

It was found in 1 home observation that the person with Down syndrome does not have access to any entertainment device. The family gave as a reason that it is because they would not know how to use entertainment devices, but the same person uses devices like tablets in the day centre without problems, which means that they could use this at home too.

Sometimes, persons with Down syndrome couldn't properly use the smart TV, as they had difficulties to use the remote control due to their problems with fine motor skills. Moreover, they could have problems to understand and follow the instructions to operate the smart TV and it could be difficult for them to navigate menus, set up and use the smart TV, or to solve technical issues. Finally, they could have limited awareness of potential hazards such as excessive screen time.

Sometimes it could be difficult to find correct apps to play games, listen to music or watch movies; or while watching a series to remember which was the last episode that they watched. Finally, some people with down syndrome have problems to read properly.

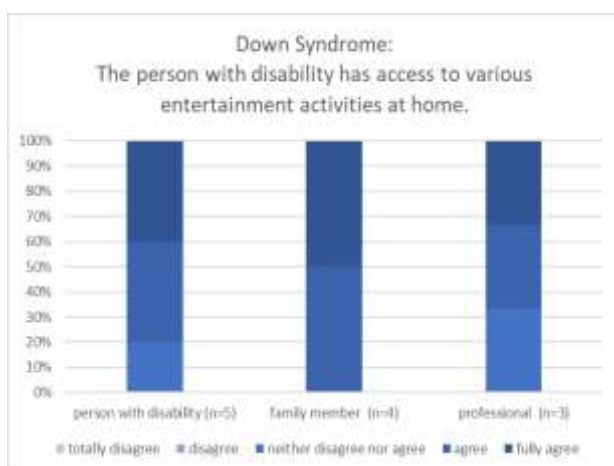


Figure 10: The person has access to various entertainment/ Communication activities (e.g. smartphone, smart tv)

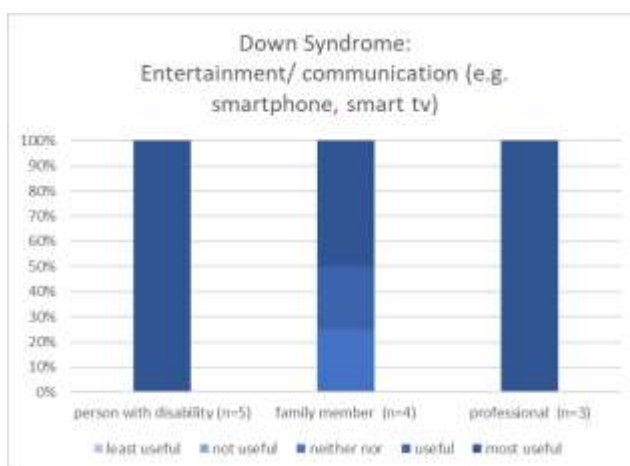


Figure 11: Most Useful Devices – activities at home

Solutions and Recommendations

- Using smart TV with a voice remote controller, to avoid remote controls with small buttons. The TV can be programmed to turn off after a certain period of time in order to avoid excessive screen time.
- Another good solution is to simplify the interface of several entertainment devices like reducing the number of options and menus and increasing the size of text and icons. Using those devices could cover some entertainment necessities like playing games, listening to music, and watching series or movies.

- Smart voice assistant could help to play music or listen audiobooks and they can be controlled with voice commands.

3.6 Cleaning, cooking and household activities Interests, needs and challenges

Based on the interviews, home observations and round table, one of the main challenges for persons with Down syndrome is to perform basic daily tasks such as cleaning, cooking and household activities. However, this problem comes less to the forefront in the questionnaire, as half of the respondents thought that this could be a problem while the other half did not agree with the sentence “Cleaning the home is a challenge for the person with disability”.

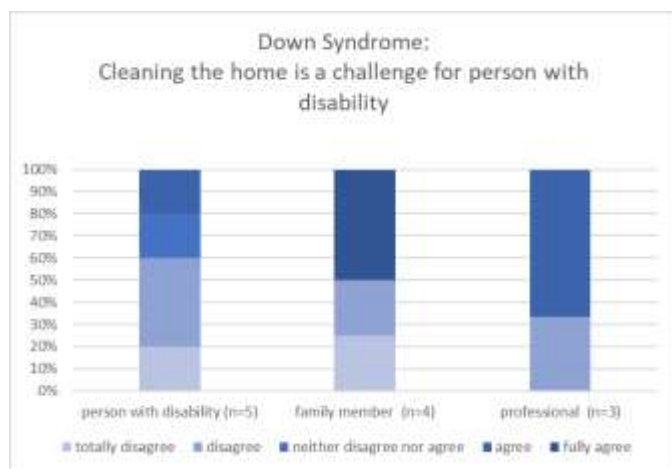


Figure 12: Cleaning the home is a challenge for the person with disability

The term household activities can cover many things like cleaning, cooking, tidying up and shopping.

A person with Down syndrome can experience problems in activities like dusting, sweeping, mopping, vacuuming, doing the laundry, and other cleaning tasks due to their problems with fine motor skills which can make it difficult to do activities that require precision and dexterity. It can also be difficult for them to know what to do and how to do some tasks for which instructions need to be followed (for example the use of a washing machine), or they can forget to do certain tasks. Moreover, they could have problems to manage their time to clean and they could start an activity and not finishing on time.

Cooking was mentioned already under previous topics because persons with Down syndrome can have problems using kitchen appliances. It therefore often happens that family members support them in these tasks or that they are not allowed to do any of these activities. This can affect their potential independence and autonomy.

In addition, safety problems may also arise with the use of cleaning products or domestic appliances. Again, they may have difficulties to recognise potential dangers; and finally, to remind how a concrete household appliance works.

About shopping, they could have problems to manage money and to decide and remember which products to buy.

Solutions and Recommendations

- Smart voice assistant can be used to remind cleaning shifts or other daily tasks. They could give voice instructions to remind them to perform those tasks or even set a timer to warn them when they are cooking. Even, it could be used to control other smart devices in the kitchen such as lights, ovens, and stoves
- Currently there is the possibility to use voice-controlled appliances in the case of ovens, stoves or microwaves which make it easier to control them and which increase safety.
- As mentioned under the topic "Home security", one of the most helpful products to avoid possible problems during cooking are the cooking robots. These devices indicate to the user the complete sequence of cooking and contribute to avoid possible problems.
- Use of cleaning robots, like robotic vacuum cleaner that can be programmed (even by voice) to clean, mop and disinfect specific areas of the home.
- Smart timers: Smart timers can be used to set and monitor cooking times, and can be controlled by voice commands, which can be especially helpful for people with Down syndrome who have difficulty with time management.

3.7 Home mobility

Interests, needs and challenges

Most of the participants taking part in the survey and interviews indicated that the person with Down syndrome does not have great difficulties to move inside home. To the question “The person with disability has difficulties in moving around their home” only 3 out of 12 agreed. In one observation, a problem with the stairs at the entrance to the house was identified.

Also, people with Down syndrome may have difficulty to move quickly in the event of an emergency, making it harder for them to escape a dangerous situation, moreover because they could not understand why it is an emergency situation or what they need to do.

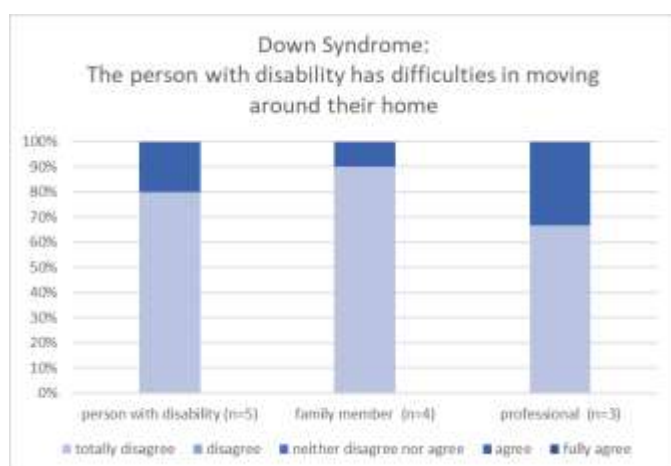


Figure 13: The person with disability has difficulties in moving around their home

Solutions and Recommendations

- For problems with climbing stairs, handrails can be installed to help the person up the stairs, using a motorised chair that works by voice commands and also connects certain household appliances when it detects that the user is coming home, such as turning on lights or the heating.
- Technological visual cues can be installed to help individuals with Down syndrome to move inside their home. For example, lights can be set to turn on when someone enters a room, or a visual indicator can be set up to show the location of the person in the home.

3.8 Energy saving Interests, needs and challenges

Based on the questionnaire, energy saving is not one of the most important topics for persons with Down syndrome or their family members, with a wide variety of different responses on this issue. Maybe the data will change in the future as society becomes more aware of the importance of taking action on these issues.

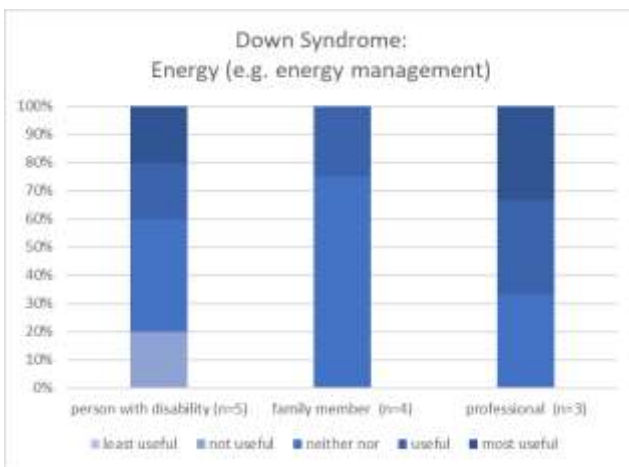


Figure 14: Most Useful Devices – Energy (e.g. energy management)

Some problems related to energy saving/sustainability were identified. For example, one person with Down syndrome did not know how to recycle and how to separate the different kinds of garbage, as he had a problem of categorization to divide the household waste.

Also, in some cases they don't know how to manage the consumption of water at home trying to not waste it. In other cases they do not understand why it is needed to turn off the light or to close the tap.

Solutions and Recommendations

- A personalised virtual assistant could help boost energy efficiency at home. The assistant provides targeted advice on the energy-saving potential of electrical appliances. It provides households with an easily referenced source of information on how to best manage energy consumption.
- An AI based camera system can be used for waste management. Those cameras use machine learning algorithms to identify and classify different types of waste, such as food scraps, paper, and plastics. The system can also detect and identify objects and

materials that do not belong in the waste stream, such as hazardous materials, and can give an alert to take appropriate action. Finally, the system can track the volume of waste in the home and alert the person with Down syndrome when the garbage or recycling needs to be taken out.

- Using Apps for visual monitoring of energy consumption. In fact, most energy distributors already offer visual apps for monitoring energy consumption – maybe some of them should improve the way of explaining it in a simpler way.
- The use of a Smart thermostats which can be programmed to adjust the temperature in the home based on occupancy or time of day, which can help reduce energy costs and save money.
- Having smart plugs because they allow the users to control any connected device (TV, washing machine, coffee makers, heaters, fans, HVAC, etc...). Users can activate/deactivate devices remotely, caregivers can check device state in real time, it is possible to program (schedule) the switching on/off of any device (for instance, switch on the washing machine or switch off TV at a certain time) and finally energy consumption can be monitored.

3.9 Social Participation

Interests, needs and challenges

About the topic of social participation, some of the respondents indicated that the person with Down syndrome is not well-connected with the community, but the answers are not univocal: Some people with Down syndrome may have problems in terms of social participation, but others may not.

A problem that was detected was the correct use of social media. In some cases the person does not understand properly which kind of message they could post on different social media channels, or they would not understand which kind of messages could be considered as inappropriate.

In social situations people with Down syndrome may have cognitive difficulties, such as memory or attention deficits, which can make it difficult to understand and participate in those kinds of situations. It is also possible that people who interact with them have a lack of understanding of the capabilities of a person with Down Syndrome and may underestimate or overestimate their potential for social participation.

Finally, people with Down syndrome may have difficulties communicating effectively with others, because they could have articulation problems, vocabulary difficulties or to express emotional messages, wants or needs. They can also have problems to understand non-verbal communication such as body language or facial expressions which can make it difficult to participate in social interactions and activities.

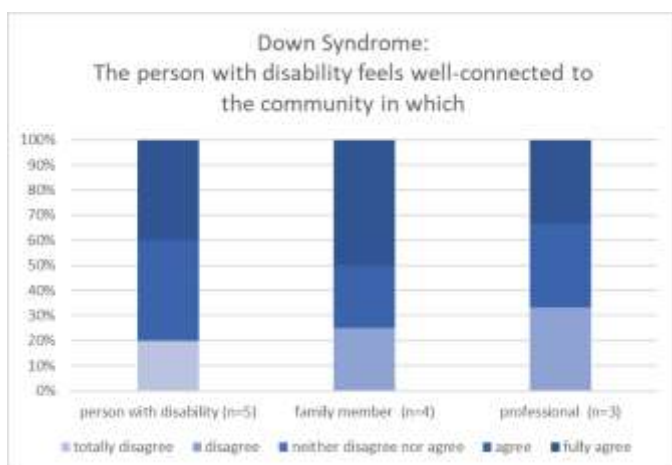


Figure 15: The person with disability feels well-connected to the community in which they live in

Solutions and Recommendations

- Apps for social media control.
- There are solutions for GPS tracking to facilitate that they could go to social activities in a safer way.

3.10 E-learning

Interests, needs and challenges

E-learning is a topic that is progressively gaining more importance because it allows for flexible and convenient access to educational materials and resources, it can also facilitate remote learning and can make education more accessible to people in areas without access to traditional schools or in case that they could have physical problems to move. It is needed to take into account that some social contact and interaction is recommended for people with Down syndrome because they could develop social skills and build relationships to have a good social network; for that reason, exclusive e-learning is not recommended.

Additionally, some problems were found with reading or writing, or other learning difficulties which may limit their access to this kind of training and its effectiveness.

Solutions and Recommendations

- There are learning apps available adapted to people with Down syndrome like “special words” to teach word recognition, spoken language, attention and listening skills, in addition to hand-eye co-ordination or apps which are designed to teach basic knowledge through assistive games.
- Use of multi-sensory e-learning to combine visual, auditory, and kinesthetic elements to engage multiple senses and make learning more interactive.
 - Use of adaptive learning which is a system that uses technology to adjust the learning experience based on the individual student's needs, abilities, and progress. It uses data and algorithms to personalise the learning content, pace, and feedback for each student.
 - Utilisation of some assistive technology e-learning: This type of e-learning uses specialised software and tools, such as text-to-speech, to help when someone has difficulty with reading or writing.
 - E-learning could be based in videos, animations and other visual aids to explain concepts and make learning more engaging; this could solve the problem with reading and writing.

4. Recommendations for the industry

- The technology for persons with Down syndrome should be simple and very easy to use. Therefore it is important to design the devices with simple and intuitive interfaces that are easy to navigate.
- It is a good idea to add voice control to most of the devices in a house of a person with Down syndrome because that makes easier to use for them.
- Install large buttons and high-contrast colours because persons with Down syndrome can have problems with small buttons or low-contrast colours..

- Persons with Down syndrome should be involved in developing and testing of products. When products are designed for them, it is better if they could give their direct opinion.

Future developments

It is important that the smart home industry will focus on solving some unsolved problems for improving the independency and autonomy of people with Down syndrome in their homes.

It could be a good idea to develop a communication system which could understand some non-verbal language of people they interact with to help persons with Down syndrome understand, and also of the persons with Down syndrome themselves, as they can have problems to express some feelings or needs. This system will help the communication and help to avoid misunderstandings. Also, a system to understand some difficult expressions which could have abstract meanings could be helpful.

More can be done to simplify the use of Smart TVs and other entertainment media, because the new television with streaming platforms is sometimes difficult to use for this target group.

Some industry efforts would have to go into improving safety inside kitchens and making this process easier, there is some progress but it could be further developed in the future.

It is the same case of healthcare, especially for the daily monitoring of important medical issues in order that professionals could receive this information immediately and users could receive feedback as soon as possible, including recommendations for action if necessary.

Solutions for the identification of persons as strangers or friends can be improved, when a person is coming to visit their house, in order to improve their safety to avoid unwanted visits.



Finally, there have been a lot of positive developments over the past years, but now there should be a focus on reducing the price of devices, as otherwise it could be very difficult to install them in real houses.



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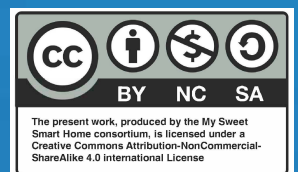
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