Modeling of patient travel costs and effects of self-care system on type 2 diabetes follow-up in North Karelia, Finland

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Background and aims

The prevalence of diabetes mellitus is increasing worldwide. In Finland there are 250 000 people living with type 2 diabetes (T2DM) and it is estimated that additionally 150 000 people have not been diagnosed. In North Karelia region prevalence of T2DM is the second highest in Finland (figure 1).

Type 2 diabetes requires regular follow-up that includes visits to primary care. Many economical evaluations carried out from a health sector perspective do not include patient time and travel costs, even though they can be in some cases considerable. In Finland health care accessibility and patient travel costs should be investigated more because of the ongoing social- and health sector reform.

All of the municipalities of North Karelia have agreed to establish a common electronic patient database, Mediatri, that could be used to obtain information on 10,204 patients who had type 2 diabetes at the end of the year 2012.

In this study the aim was to model T2DM follow-up related health care accessibility, annual patient travel costs and health care costs. In addition, two scenarios were built to test cost effects of removal of the number of public health care centers and to predict how development of self-care system can help reducing amount of travel and costs.

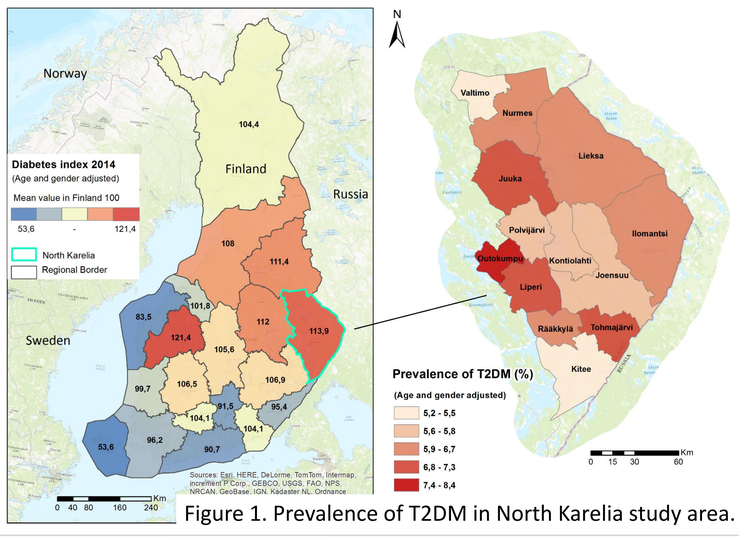


Figure 1. Prevalence of T2DM in North Karelia study area.

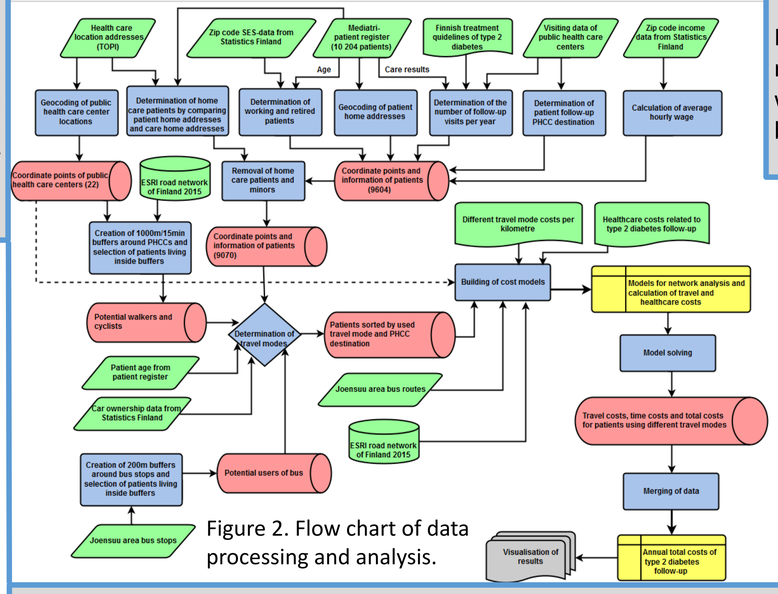


Figure 2. Flow chart of data processing and analysis.

Modeling of patient travel costs and health care costs

All data processing (figure 2) was made by using ESRI ArcGIS 10.3 software.

Modeling of patient travel costs and health care costs was carried out by building cost models for different travel modes (walking, cycling, car, bus, taxi) with ArcGIS Model Builder tool (figure 3). In all models OD Cost Matrix Network Analyst tool (figure 4) was used to create fastest and shortest routes from patient home locations to destination public health care centers. Used road network dataset is a product of ESRI Finland.

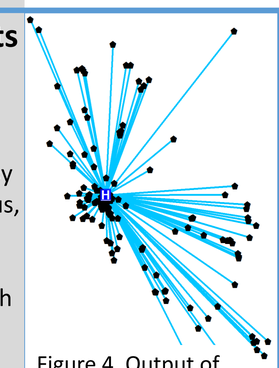


Figure 4. Output of OD Cost Matrix tool.

For first scenario analysis, 3 PHCCs were removed with Minimize Impedance problem type of the Location-Allocation tool (figure 5). Location-Allocation could be used to allocate population demand for 19 of 22 PHCCs of the study area. That way it was possible to locate most important PHCCs, while least important health centers could be removed for the tested scenario. After reducing the number of PHCCs by 3, travel costs were recalculated.

For second scenario, cost models were edited to take into account diabetes self-care system that reduces annual follow-up visits to half and replaces some of the blood glucose measurements with self-measurements made by patients. Cost savings of self-care system were calculated in baseline and after removal of 3 PHCCs.

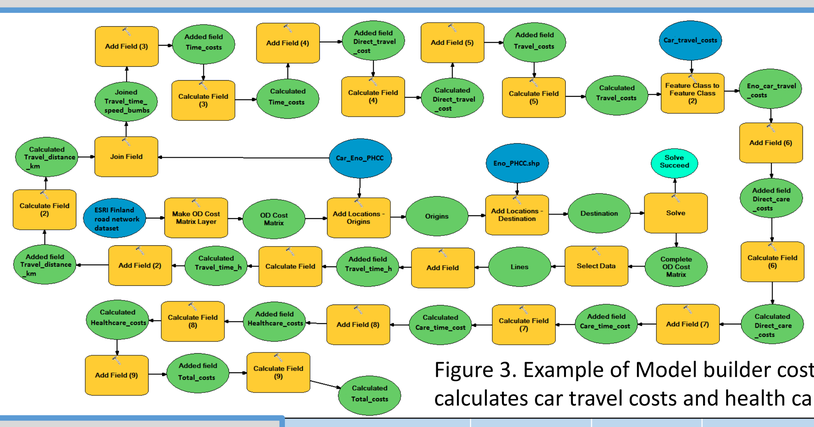


Figure 3. Example of Model builder cost model that calculates car travel costs and health care costs.

Results

With cost models it was possible to calculate total costs of type 2 diabetes follow up in North Karelia (figure 6). Patient travel costs form 16 % of total annual costs and when considering both travel and time costs the share is 21 % (figure 7).

Both annual and one trip travel costs increase when moving further away from health centers (figures 8 and 9). There can also be found multiple hotspot areas where travel costs are considerably higher than elsewhere. Some public health care centers are on average more expensive travel destinations, because they serve large areas where accessibility is weak (figure 9).

When reducing the number of public health care centers by 3, the rise of travel costs is important for an individual trip, but not for the total costs of the study area (figure 10). In this scenario, 460 T2DM patients were relocated to the second nearest PHCC, which increased their average annual travel costs by 196,3 %.

If patients make half of the annual control measurements by themselves, the number of follow-up trips declines substantially, which reduces traveling costs and regional differences (figure 11). Some high cost hotspots still remain, as all patients over 80 years use taxi because of high age. In self-care scenario, total annual costs of T2DM follow-up is reduced from 2,5 mill. € to 1,1 mill. € (56,8 %). Annual health care costs are reduced from 2 128 412 € to 942 550 € (55,7 %) and travel costs are reduced from 406 967 € to 152 380 € (62,6 %).

After reducing the number of PHCCs by 3, self-care system can compensate the rise of annual travel costs of those 460 relocated patients. With implemented self-care, average annual travel costs increase only 13,3 % compared to the 196,3 % in baseline.

	Annual	Share of total costs (%)	Annual average cost per patient	Average cost of one follow-up
Total costs of type 2 diabetes follow-up	**2 535 348,62 €**	**100 %**	**279,53 €**	**78,09 €**
Health care costs	**2 128 412,04 €**	**83,95 %**	**234,67 €**	**65,56 €**
Direct cost of health care and blood glucose tests	2 012 830,00 €	79,39 %	221,92 €	62,00 €
Value of care time	115 582,04 €	4,56 %	12,74 €	3,56 €
Travel costs	**406 936,58 €**	**16,05 %**	**44,87 €**	**12,53 €**
Direct monetary cost of travel	334 052,89 €	13,18 %	36,83 €	10,29 €
Value of travel time	72 883,69 €	2,87 %	8,04 €	2,24 €

Figure 6. Total costs of T2DM follow-up.

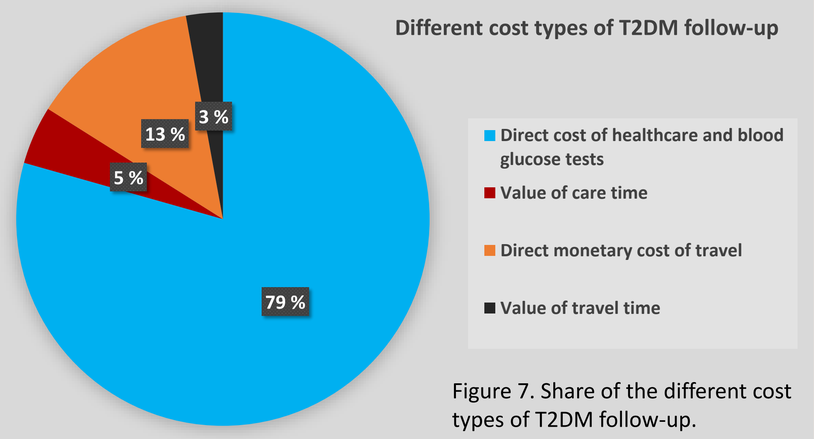
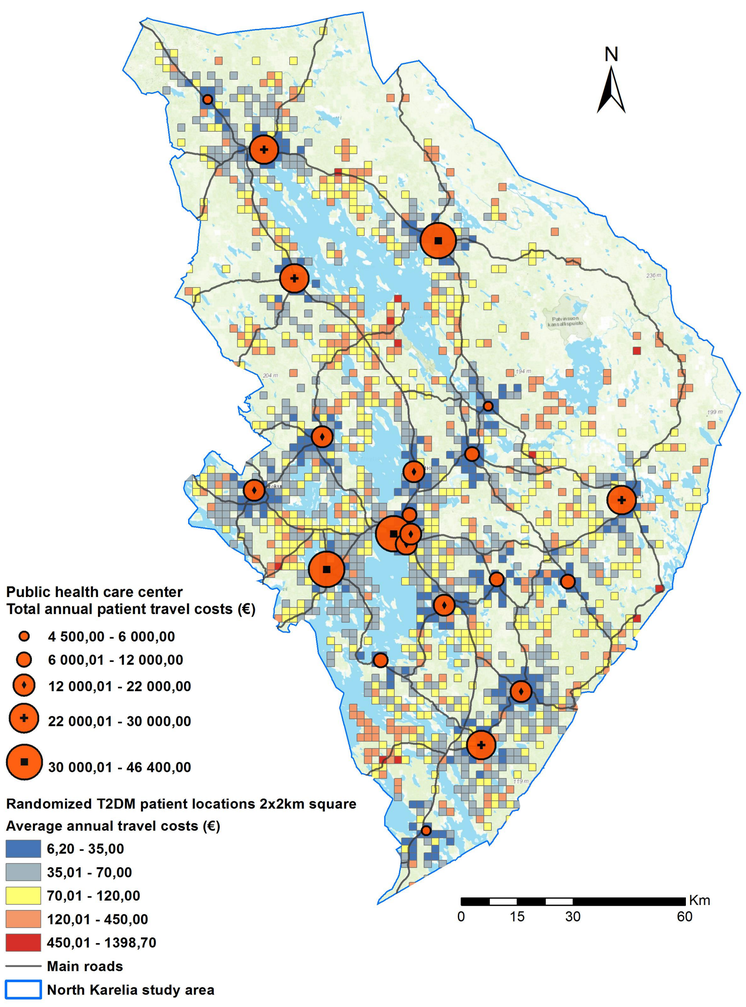


Figure 7. Share of the different cost types of T2DM follow-up.



Note: subject locations have been randomly shifted to protect confidentiality.

Figure 8. Annual patient travel costs.

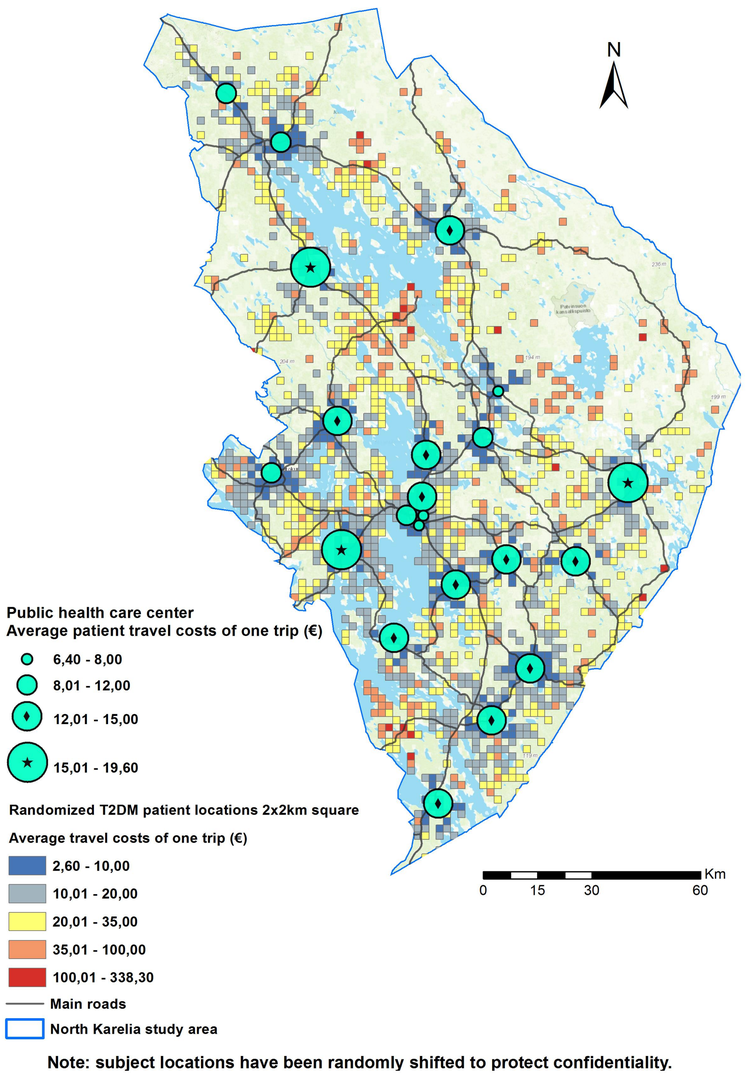


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Figure 9. Travel costs of one trip.

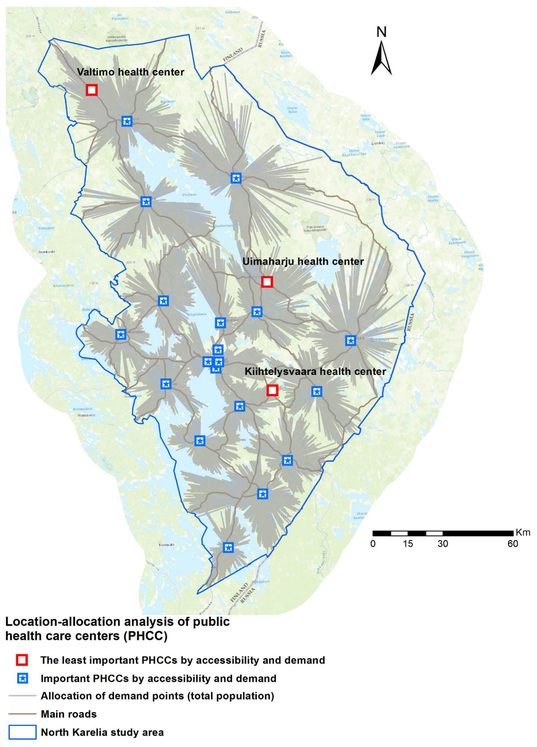

Figure 5. Location-allocation analysis to remove 3 PHCCs.

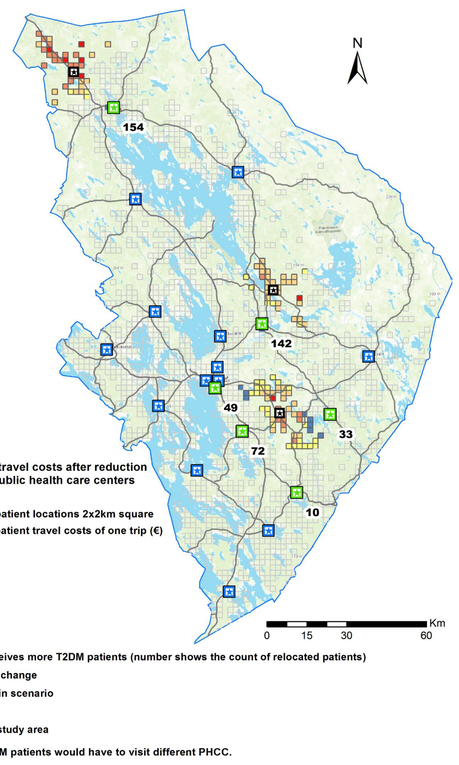

Figure 10. Travel costs of one trip after reducing the number of PHCCs by 3.

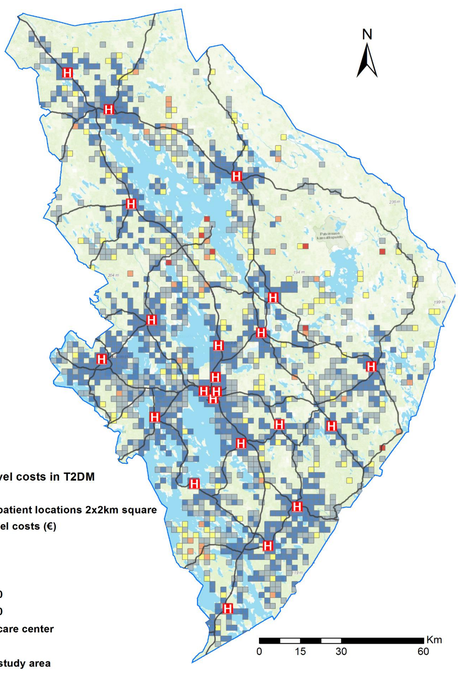

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Figure 11. Annual patient travel costs after self-care is implemented.

Discussion and conclusions

This study demonstrates that patient time and travel costs should be included to economical evaluations of health care or intervention that requires regular monitoring and traveling. In type 2 diabetes follow-up, major savings in both health care and travel costs can be achieved with working patient self-care system and self-measurements. Thus, more emphasis should be laid on diabetes self-measuring in primary health care.

GIS and patient registers offer many possibilities for research in health sector and geography. Cost models used in this study can be developed and expanded further. Models can also be used on different geographical areas and for many other illnesses, like cancer and cardiovascular disease.