

EPI302 Miniproject

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Introduction

National research program

- ▶ Conducted by Swiss Diabetes Registry
- ▶ Longitudinal cohort study of 102949 Diabetes patients from all Swiss cantons from 2002 to 2012
- ▶ Intervention: Tailored treatment protocols for Diabetes patients (Physical activity, Pharmacotherapy) and control
- ▶ Outcomes:
 - ▶ Healthcare accessibility and delivery
 - ▶ Individual and population health
 - ▶ Health care system outcomes and variation in care

NRP - Intervention assignment regions

Patients were assigned to an intervention by canton of residence.

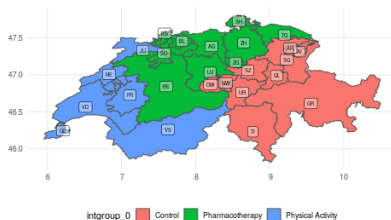


Figure 1: Treatment allocations

Project responsibilities

- ▶ Andre Moser (Course administrator)
- ▶ Joël Meili (Project leader, RQ1)
- ▶ Xijin Chen (RQ2)
- ▶ Thomas Fischer (RQ3)

Healthcare accessibility and delivery (RQ1)

What are the positive and negative effects of the treatment protocol related to access and delivery of Diabetes care?

- ▶ First, establish a definition of access and delivery of health care
- ▶ Second, formulation of possible hypotheses
- ▶ Third, use the provided data set to analyze and try to evaluate the proposed hypotheses

Access to Diabetes care

We used the five dimensions of health care that were proposed in the lecture where:

- ▶ **Availability:** is the relationship between supply and demand for health care services
- ▶ **Accessibility:** is the geographical proximity to health care providers
- ▶ **Accommodation:** is the relationship between how health care services are organized and the client's ability to accommodate these factors.
- ▶ **Affordability:** is the costs of health care services and the ability of a patient to cover
- ▶ **Acceptability:** is the patient's attitude towards the perceived characteristics of an intervention

Delivery of Diabetes care

We used adherence to treatment guidelines as the definition to delivery of Diabetes care. In this example the NRP used an overall guideline score, which consists of the accrual of the following parameters:

- ▶ **HBA1C level <53 mmol/mol:** 12 points
- ▶ **HBA1C level <64 mmol/mol:** 8 points
- ▶ **HBA1C level <75 mmol/mol:** 5 points
- ▶ **three GP visits per year:** 10 points
- ▶ **physical activity:** 5 points
- ▶ **stop smoking:** 5 points

Formulation of hypotheses - Access to Diabetes care

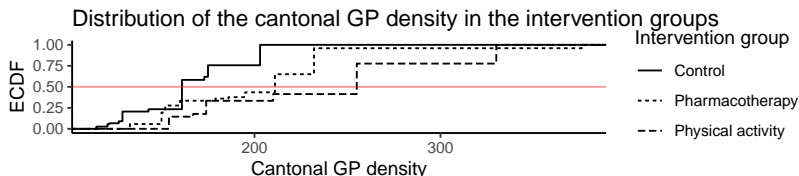
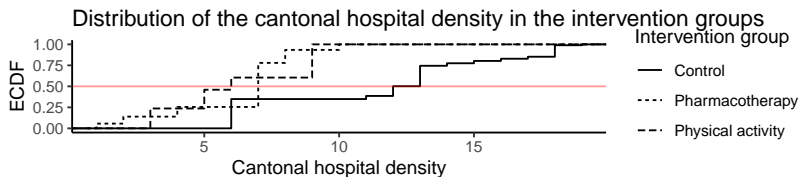
- ▶ The provided data only allowed for the analysis of the dimension of accessibility and affordability
- ▶ There was no data to analyze the development of the accessibility
 - ▶ Assumption: number of hospitals and GPs stayed relatively constant (short follow-up period)
- ▶ As there is intensified use of Metformin in the pharmacotherapy group we could expect that the affordability of Diabetes care is decreased as the costs increase
- ▶ Further, we thought that as the treatment groups receive additional recommendations regarding their health, we could expect that patients in the intervention groups are more health literate compared to control

Formulation of hypotheses - Delivery of Diabetes care

- ▶ We expect the overall adherence to guidelines score to be increased in the intervention groups compared to control as the additional, specialized treatment should increase their overall well-being

Analysis and results - Accessibility

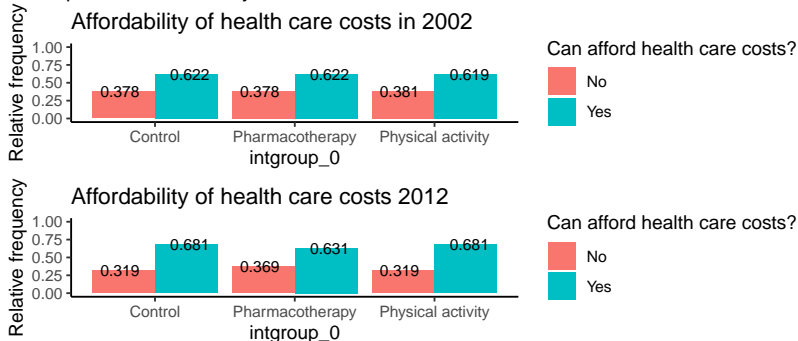
- ▶ The following figure shows that the accessibility to hospitals was larger in the control group than in the intervention groups
- ▶ However, the accessibility to GPs is larger in the intervention groups than in the control group
- ▶ We assume that the intervention groups were chosen in that manner to observe a strong effect in the intervention groups



Analysis and results - Affordability

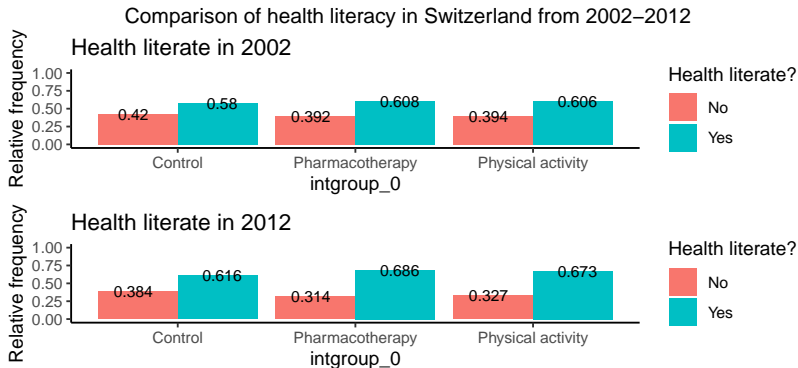
- ▶ We can see that the overall affordability of health care costs has increased from 2002 to 2012 in all three treatment groups
- ▶ Further, the proportional increase in the pharmacotherapy group is not as large as in the other two treatment groups
- ▶ As the affordability has also increased in the control group, we cannot conclude that the treatment protocol had a positive effect on the affordability of health care costs

Comparison of the ability to afford health care costs in Switzerland from 2002–2012



Analysis and results - Health literacy A

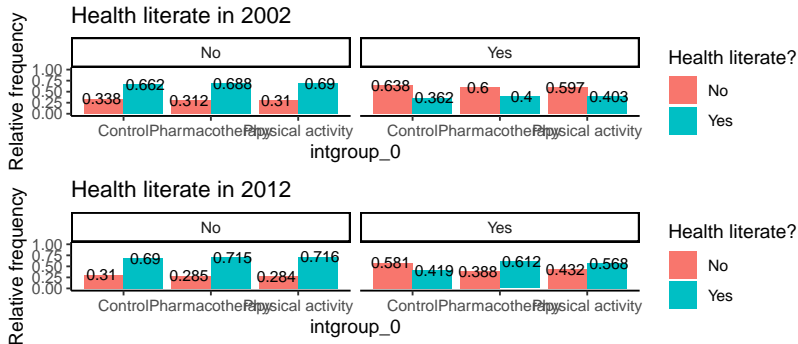
- ▶ We can see that the overall health literacy has improved in all three treatment groups
- ▶ However, the proportional growth is not as large in the control group as was to be expected



Analysis and results - Health literacy B

- ▶ Further analysis shows that the treatment protocol was especially efficacious in persons with migration background
- ▶ We assume that they were not able to get proper treatment and that the additional recommendations have really helped those to improve their well-being who were not aware of additional treatment

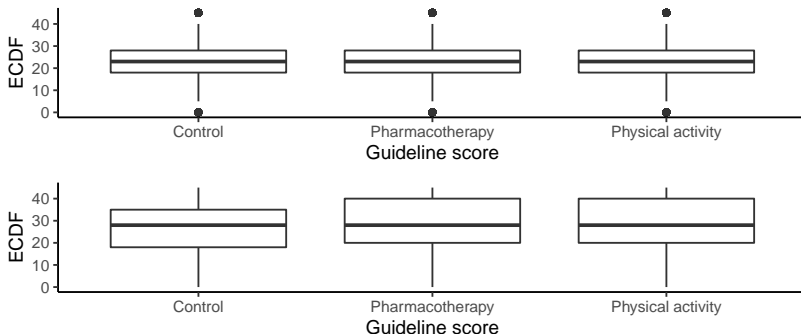
Comparison of health literacy in Switzerland from 2002–2012



Analysis and results - Delivery

- ▶ The figure shows that the overall adherence has increased for all three treatment groups
- ▶ The assumed difference between the treatment group however is not substantial
- ▶ We assume that because of the information era that we are living in now, people live generally healthier now than in 2002

Comparison of adherence treatment guidelines in Switzerland from 2002–2012



Conclusion

- ▶ We found it difficult to assess if the treatment protocol had a positive or negative influence on the access and delivery of Diabetes care
- ▶ We also think that it is probably difficult in general to measure variables that really contribute to the subject, especially in only 10 year-follow up period

Individual and population health (RQ2)

Introduction

Discussion

- ▶ Clinical guidelines intend to improve the quality of care.
- ▶ Can also introduce economic inefficiencies, and invite over-use.
- ▶ Signs of overtreatment than undertreated for diabetes.
- ▶ Guidelines need to be designed based on substantial evidence

Over-treatment can be defined as an unnecessary or over-use of treatment. It may lead to potential patient harms and excessive costs in health care. In this project, we have noticed that the use of intensive Glycemic control, Metformin has no positive result for patients, in terms of health-related quality of life, while the problem of adverse events is a big issue. The problem on the cost is also obvious. Alternatively, physical activities are more recommended in terms of clinical efficiency.

Figure 1

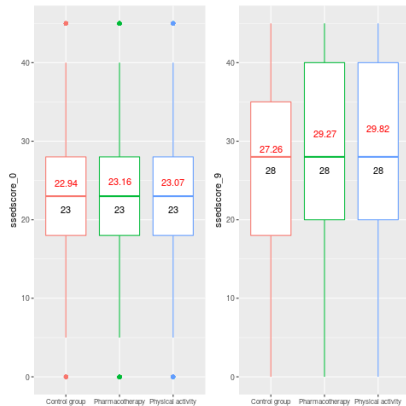


Figure 2: Average residual CPQ

Figure 2

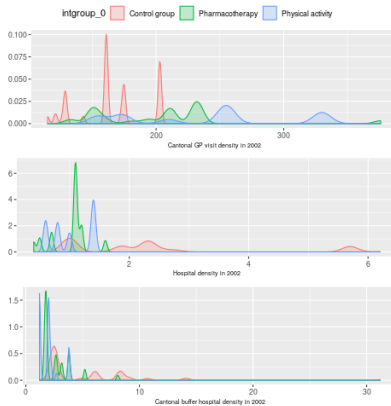


Figure 3: Average residual CPQ

Health care system outcomes and variation in
care (RQ3)

Introduction

Research question: how does the intervention affect health care system outcomes and variation in Diabetes care?

- ▶ Health care systems provide a service, and operate on a budget
- ▶ Service quality and cost-effectiveness are important performance measures and may vary by hospital, canton, or region
- ▶ Quality adjusted life years (QALY): defined as number of years under observation discounted by quality of life
- ▶ High QALY implies effective and efficient treatment (low mortality, high quality of life)
- ▶ Low QALY can imply overtreatment (negative side effects from drug treatments)

Introduction

Question: what do we mean by variation?

Answer: under- or overuse of a treatment

- ▶ Effective care: treatments are chosen based on the available evidence
- ▶ Patient sensitive care: shared decision making between physicians and patients. Patient preferences factor into treatment choices
- ▶ Supply sensitive care: Treatment selected by availability and necessity

Introduction

Intervention characteristics:

- ▶ Treatment protocols provide patients with information intended to change their behaviour (Nudging)
- ▶ Physicians and general practitioners also received specialized training

Hypotheses:

- ▶ Tailored treatment protocols are associated with increased quality adjusted life years (QALY)
- ▶ Tailored treatment protocols are associated with lower costs per QALY

Method

- ▶ Exploratory data analysis
- ▶ A linear regression model was used to estimate the intervention effect on QALY
- ▶ A log-linear regression model was used to estimate the intervention effect on cost per QALY
- ▶ Variability in care was evaluated graphically using proportions

Results - Observations from data analysis

- ▶ Regression to the mean: patient reported Health-related quality of life (HrQOL) more moderate in 2012 than in 2002 (cf. Figure 4)
- ▶ Cumulative costs were surprisingly low for some patients with comorbidities in 2002 and with CVD
- ▶ This did not occur for patients with no comorbidities in 2002 (cf. Figure 5)
- ▶ Intuition: inpatient treatments for CVD are expensive. Costs should therefore increase substantially with each hospitalisation
- ▶ Indication for the existence of a (unknown to us) source of variation related to comorbidities?

Results - Observations from data analysis

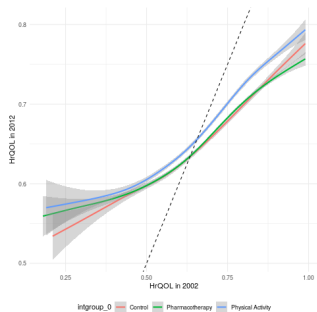


Figure 4: HrQOL in 2002 and 2012

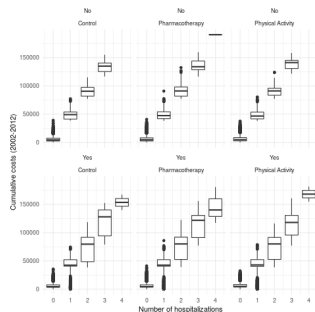


Figure 5: Hospitalisations and cumulative cost stratified by presence of comorbidities in 2002 and intervention

Results - Quality of care

	Model 1	Model 2	Model 3	Model 4
(Intercept)	5.330*** (0.019)	5.295*** (0.021)	-0.708*** (0.014)	5.395*** (0.010)
age65_0>= 65 years	-1.009*** (0.007)	-1.009*** (0.007)	-0.562*** (0.003)	-0.575*** (0.003)
female_0Female	0.076*** (0.006)	0.076*** (0.006)	-0.000 (0.003)	-0.000 (0.003)
pa_0Moderate-High	1.111*** (0.007)	1.112*** (0.007)	1.082*** (0.003)	1.121*** (0.003)
metformin_0Yes	-0.192*** (0.007)	-0.192*** (0.007)	-0.205*** (0.003)	-0.211*** (0.003)
hosp10kmdens_0	-0.005*** (0.001)	-0.001 (0.001)	-0.000 (0.001)	-0.000 (0.001)
comorb1_0Yes	0.015* (0.007)	0.015* (0.007)	0.024*** (0.003)	0.025*** (0.004)
hrqol_0	1.493*** (0.028)	1.493*** (0.028)	1.451*** (0.013)	1.460*** (0.014)
intgroup_0Pharmacotherapy		-0.000 (0.009)	-0.001 (0.004)	-0.001 (0.004)
intgroup_0Physical Activity		0.088*** (0.010)	0.082*** (0.005)	0.084*** (0.005)
obstime			0.612*** (0.001)	
R ²	0.476	0.476	0.887	0.761
Adj. R ²	0.475	0.476	0.887	0.761
Num. obs.	102949	102949	102949	96604
RMSE	0.945	0.944	0.439	0.437

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table 1: Statistical models

Results - Quality of care

- ▶ Strong evidence for a negative association between the age and metformin treatments with QALY
- ▶ Effect is outbalanced by physical activity and baseline level of health-related quality of life
- ▶ Hospital density only significant in baseline model
- ▶ Strong evidence for a positive effect of physical activity protocol, but questionable practical significance (approx. 1 month)
- ▶ No evidence of any effect for the pharmacotherapy protocol
- ▶ Estimates stable across different model specifications (adjusting for obstime, excluding dead patients)

Results - Cost-effectiveness

	Model 1	Model 2	Model 3	Model 4	Model 5
(Intercept)	7.188*** (0.008)	7.155*** (0.014)	6.610*** (0.009)	6.578*** (0.009)	6.590*** (0.009)
age65_0>= 65 years	0.134*** (0.008)	0.134*** (0.008)	0.123*** (0.005)	0.125*** (0.005)	0.160*** (0.005)
pa_0Moderate-High	-0.295*** (0.008)	-0.295*** (0.008)	-0.116*** (0.005)	-0.115*** (0.005)	-0.119*** (0.005)
comorb1_0Yes	0.004 (0.009)	0.004 (0.009)	-0.169*** (0.006)	-0.171*** (0.005)	-0.169*** (0.005)
hosp10kmdens_0	-0.008*** (0.002)	-0.005** (0.002)	-0.004*** (0.001)	-0.005*** (0.001)	-0.005*** (0.001)
metformin_0Yes	0.208*** (0.009)	0.208*** (0.009)	0.318*** (0.006)	0.319*** (0.006)	0.317*** (0.006)
hrqolcat_0Yes	-0.036*** (0.010)	-0.036*** (0.010)	-0.002 (0.006)	0.002 (0.006)	0.001 (0.006)
intgroup_0Pharmacotherapy		0.026* (0.011)	0.031*** (0.007)	0.032*** (0.007)	0.034*** (0.007)
intgroup_0Physical Activity		0.041*** (0.012)	0.047*** (0.008)	0.047*** (0.008)	0.049*** (0.008)
hosp			1.736*** (0.004)		
log(hosp + 1)				2.794*** (0.007)	2.758*** (0.007)
R ²	0.033	0.033	0.611	0.634	0.647
Adj. R ²	0.033	0.033	0.611	0.634	0.647
Num. obs.	102949	102949	102949	102949	96604
RMSE	1.155	1.155	0.732	0.710	0.691

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table 2: Statistical models

Results - Cost-effectiveness

- ▶ log-linear model: coefficients not as straightforward to interpret, but necessary compromise
- ▶ Costs per QALY increase with age and metformin treatment, and decrease with physical activity, comorbidities and baseline HrQOL, but not in all models
- ▶ Hospital density decreases cost per QALY, but questionable practical significance
- ▶ Hospitalisations included to account for large costs arising from inpatient treatments
- ▶ Strong evidence for a positive association of both intervention protocols with cost per QALY
- ▶ This implies that both interventions are less cost-effective than the control

Results - Variation in use of metformin

- ▶ Predominantly no deviation from established treatment
- ▶ Transitions into metformin treatment were more common in the pharmacotherapy region than elsewhere
- ▶ Table 1 indicated negative effect of metformin on QALY, and no effect of pharmacotherapy protocol compared to control
- ▶ Suggestive of overuse of metformin

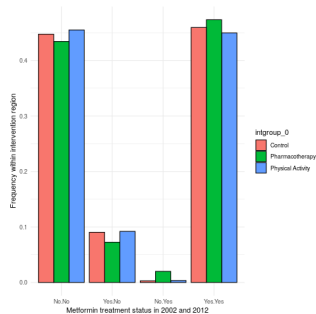


Figure 6: Frequency of treatment progressions within intervention groups

Results - regional variations in quality of care

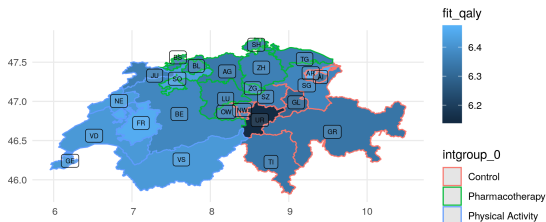


Figure 7: Average predicted QALY

Results - regional variation in cost-effectiveness

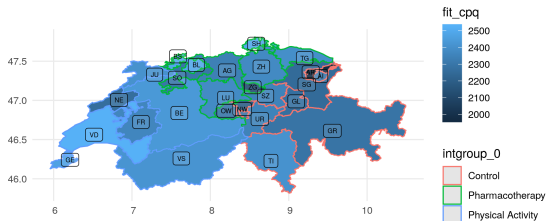


Figure 8: Average predicted CPQ

Discussion - health care outcomes and variation

- ▶ The physical activity protocol appears to be more beneficial than either the control or the pharmacotherapy protocol
- ▶ Both treatment protocols were less cost-effective than the control
- ▶ Results are in line with those of similar studies (such as Herman [2015])
- ▶ Patients were newly prescribed metformin prescriptions more frequently in the pharmacotherapy region, suggesting overuse of metformin
- ▶ Plausible explanation: physicians and patients were sensitised by the information provided by the treatment protocol

Discussion - Regional variation

- ▶ Canton Uri had the lowest average QALY. This was in line with our expectations. It also underperformed with respect to CPQ
- ▶ Appenzell-Ausserrhoden outclassed its neighboring cantons on QALY and exceeded our expectations
- ▶ Large difference between Appenzell-Innerrhoden and Ausserrhoden with respect to cost-effectiveness
- ▶ Could indicate that intercantonal competition is a factor

Discussion - Limitations

- ▶ Lack of randomization: interventions assigned to patients by canton of residence. Hence, our results are only observational
- ▶ Lack of information about medical history of individual patients
- ▶ Relatively long follow-up time may be appropriate to study properties of the health care system, but much can change in 10 years for a patient
- ▶ Model assumptions do not hold up for the models of cost per QALY

Discussion - Implications of findings

- ▶ Cost-benefit analysis indicates that neither treatment protocol should be implemented from an economic perspective
- ▶ However: QALY significantly increased under the physical activity protocol
- ▶ Further benefits could manifest in the long-term
- ▶ Future research should explore the effectiveness of physical activity protocol in a randomized trial.

William Herman. The cost-effectiveness of diabetes prevention: results from the diabetes prevention program and the diabetes prevention program outcomes study. *Clinical Diabetes and Endocrinology*, 2015.