THE APPLICATION OF FORMAL CONCEPT ANALYSIS AND THE IMPORTANCE OF SCALE SELECTION IN THE EVALUATION OF PHYSICAL ACTIVITY DATA IN RELATION TO THE BODY MASS INDEX

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Submitted in May, 2009

BACKGROUND: Research confirms that physical activity (PA) is irreplaceable in a healthy and physically active lifestyle. One of the key research questions is what the optimal level of everyday PA for health is and how it should be quantified and interpreted. Formal concept analysis is one possible way of how to assess and describe the level of PA as related to personal data.

OBJECTIVE: The main goal of this study was to introduce the method of Formal Concept Analysis (FCA) using data from the ANEWS questionnaire and data from the objective monitoring of a number of steps using the YAMAX SW-701 pedometer. A further aim was to adopt the most appropriate method within the FCA.

METHODS: A random sample of 273 males aged 18–69 from selected regional centers participated in the study.

RESULTS: The example of daily steps allows for the demonstration of how important it is to select a scale in FCA data analysis. It is better to use an ordinal scale for the daily number of steps (in our example); because, in so doing, we create the attributes that can be ordered (a lower number of steps is also insufficient).

CONCLUSIONS: A rough scale produces easier lattice with the general scope of the observed attributes. The smoothing of the scale produces more difficult lattice and makes for more difficult analyses, but gives more detailed results. FCA requires more expertise from a researcher than do "classical" testing statistics, but gives us deeper insight into the examination of the problem.

Keywords: Nominal and ordinal scale, fuzzy, aggregated object, lattice, steps, men.

INTRODUCTION

Physical activity (hereafter PA) is of key importance to a healthy and physically active lifestyle in adults. Yet the optimal level of its daily amount and the method of its exact quantification have not been clearly identified. A daily number of steps appears to be a simple and comprehensible "quantifier" (Tudor-Locke, Ainsworth, Thompson, & Matthews, 2002) and pedometers (especially YAMAX brand) are reliable and exact enough to measure the steps (Crouter, Schneider, Karabulut, & Bassett, 2003; Le Masurier, Lee, & Tudor-Locke, 2004; Schneider, Crouter, & Bassett, 2004). The choice of appropriate and verified techniques and variables is a necessary condition that needs to be met in order to describe various phenomenona properly. Moreover, an appropriate method of data processing and interpretation are also important. When only either a quantitative or qualitative approach is used, that has its limits, which can be overcome to some extent by the combination of both quantitative and qualitative methods used, for example, in PA meta analysis (Sallis & Owen, 1999). The "adjustment" of data to the possibilities of statistical methods can lead sometimes to a biased interpretation of the tested aspect. For example, the frequent use of regressive analysis in behavioral studies can also contribute to data misinterpretation. Therefore, the main aim of this study is to introduce the method of Formal Conceptual Analysis as applied to a data sample from the ANEWS questionnaire and the number of steps obtained from the YAMAX pedometer. A further goal of the study is to discuss the choice of an appropriate scale in Formal Conceptual Analysis.

METHODS

Participants

A random sample of 273 males aged 18–69 from selected regional centers participated in the study. The chosen men fully and correctly completed the ANEWS questionnaire and weekly physical activity monitoring using Yamax SW–700 pedometers in Spring and Autumn of 2007.

The level of the body weight of participants was classified according to the Body Mass Index (BMI – $kg \cdot m^{-2}$)

as follows: < 18.5 (underweight), 18.5–24.9 (normal weight), 25–29.9 (overweight) and ≥ 30 (obese) (World Health Organization, 1995).

ANEWS questionnaire

The ANEWS questionnaire, the Neighborhood Environment Walkability Scale – Abbreviated (www.ipen-project.org/surveyanews.htm) includes 54 questions on the environment of neighborhoods, which are divided into several categories: D) types of residences in your neighborhood, E) stores, facilities, and other things in your neighborhood, F) access to services, G) streets in my neighborhood, H) places for walking and cycling, I) neighborhood surroundings and J) neighborhood safety. The answers to individual questions in category D) are scored as: 1 – none, 2 – a few, 3 – some, 4 – most, 5 – all. All 23 questions in the E) category can be answered as: 1 – 1–5 min, 2 – 6–10 min, 3 – 11–20 min, 4 – 20–30 min, 5 – ≥ 30 min and the possibility, "I don't know". Categories F) to J) are scored as follows: 1 – strongly disagree, 2 – somewhat disagree, 3 – somewhat agree, 4 – strongly agree.

Pedometr Yamax SW-701

The Yamax Digiwalker SW–701 (Yamax Corporation, Japan) is a light (20 g), small commercial electronic pedometer that measures vertical oscillations (Schneider, Crouter, & Bassett, 2004). Yamax uses a spring suspended lever that moves in response to the hip's vertical oscillations. The movement opens and closes an electrical circuit, and each vertical oscillation detected above a critical threshold (0.35 g) is registered as a step taken (Tudor-Locke et al., 2002). Total numbers of counted steps are displayed on a small screen.

In general, pedometers are most accurate in counting steps, less accurate in calculating distance, and least accurate at estimating energy expenditure (Crouter et al., 2003). Because steps are the most direct expression of what the pedometer actually measures, Tudor-Locke and Myers (2001) recommend reporting pedometer data as steps.

Formal Concept Analysis

In area data mining we often have the problem, that we obtain o lot of data and we are looking for a tool, which will allow us to make this data concrete or generalize it. Formal Concept Analysis (FCA) is a very good tool for this work (Ganter & Wille, 1999). FCA works with a formal context.

Formal context *is* $\mathcal{K} = (X, Y, I)$ where X is a set of objects, Y is a set of attributes and I is a binary relationship between X and Y, xIy or $(x, y) \in I$ meaning that the object x has the attribute y.

For each $A \subseteq X$ defined $A^{\uparrow} = \{y \in Y | xIy \text{ for each } x \in A\}$(set of all attributes, which have objects from A). Similarly, for subset $B \subseteq Y$ define: $B^{\downarrow} = \{x \in X | xIy \text{ for each } y \in B\}$ (set of all objects, which have attributes from B).

Formal concept from the context (X, Y, I) there is a pair (A, B), where $A \subseteq X$, $B \subseteq Y$, $A^{\uparrow} = B$ and $B^{\downarrow} = A$. Set A we call extent, and set B the intent of concept (A, B).

Therefore, $\subseteq$ models the natural subconcept–superconcept hierarchy. The set of all concepts form the context (X, Y, I), which we denote as follows: $\mathbb{B}(X, Y, I)$. It is a concept lattice, the basic structure of which is described by the so called main theorem of concept lattices (Ganter & Wille, 1999).

The questionnaire consists of questions to be answered by respondents by selecting an answer from a list of possible answers. From the point of view of FCA, we can consider the set of respondents as the set of objects and the set of single questions as the set of attributes. The questions need not be yes/no questions. Rather, some questions like those concerning age and education are many valued. Correspondingly, a completed questionnaire can be represented by a many valued formal context. With this type of context FCA doesn't work. Therefore we have to transform this many valued context to a bivalent context. This process we called concept scaling.

Concept scaling

Scaling is a transformation of a many-valued context to a bivalent context. The basic scales being used in FCA are described in Ganter and Wille's (1999) book. Some important facts are presented below.

Nominal scales

Nominal scales are used to place attributes on a scale, the values of which mutually exclude each other. One example from ANEWS could be information about our repondents' way of life: *alone*, *family without children* or *family with children*. In this case we use a nominal scale and offer a choice of three attributes: alone, family without children, family with children (TABLE 1). If respondent *XY* fills in that he lives alone, then in context it looks like this: $(XY, alone) \in I$, $(XY, family\ without\ children) \notin I$ a $(XY, family\ with\ children) \notin I$.

The dichotomic scale

The dichotomic scale constitutes a special case of nominal scale. It is frequently used to place attributes with yes/no values onto a scale. An example from ANEWS could be the question if the respondent does work for pay. We use the dichotomic scale and offer a choice of two attributes: employment – YES, employment – NO (TABLE 2). If respondent *XY* fills in that he works for pay, than in context it

looks like this: $\langle XY, employment - YES \rangle \in I$ and $\langle XY, employment - NO \rangle \notin I$.

TABLE 1
Example of the creation of a nominal scale in the question of the lifestyle of a participant (ANEWS questionnaire)

Questionnaire		Context (lifestyle)			
Participant	Answer		Alone	Family without children	Family with children
A	1	A	1	0	0
B	2	B	0	1	0
C	3	C	0	0	1

TABLE 2
Example of the creation of a dichotomic scale in the question of work for pay of a participant (ANEWS questionnaire)

Questionnaire		Context (employment)	
Participant	Answer	Employment – YES	Employment – NO
A	1	1	0
B	0	0	1

Ordinal scales

Ordinal scales can be used to place many valued attributes on a scale, the values of which are ordered and where each value implies the weaker ones. We can use the ordinal scale for the number of steps counted by the pedometer. When we use an ordinal scale, we list five possible attributes for steps: low active (sedentary), somewhat active, active, highly active and "extremely" active (TABLE 3).

Aggregated objects

Typically, such a formal context contains many objects and a manageable number of attributes. The corresponding concept lattice is too large for an expert to comprehend. In addition, the expert might not be interested in the formal concepts from this concept lattice. Rather, the expert might want to consider aggregates of the individual respondents as objects in the formal context with the aggregates defined by having the same attributes. This is the main idea of so called "aggregated objects" (Bělohlávek, Sklenář, Zacpal, & Sigmund, 2007).

The basic idea is to choose a set S of attributes specified by an expert, such as gender – male, gender – female, etc., with S being a subset of the set Y of all attributes. Attributes from S will be called "characteristic attributes". By these attributes we aggregate respondents (objects). For example, we have the characteristic attributes of gender (gender – male, gender– female), a job (job – yes, job – no) and ownership of a car (car – yes, car – no), then the set of aggregated objects replaces the set of objects – respondents. Each aggregated object represents the group of respondents which has the same characteristic attributes. For example: "a man, who owns a car and has a job" (objects, which are related to the attributes gender – male, car – yes, job – yes). We replace the binary relation with a fuzzy relationship between aggregate objects and attributes, where the true degree expresses what percentage of respondents has this property (relative frequency between original objects and attributes). For example, if we have a true degree between an aggregated object with the characteristic attributes of gender – male, job – yes, car – no and attribute dog – yes 0.49, it expresses, that 49% of men, who have a job and don't have a car, own a dog.

Using the above described transformation, we obtain a formal fuzzy context. Instead of the classical set we have fuzzy sets and use fuzzy logic instead of classic logic (Bělohlávek, 2002). Now we have calculated a fuzzy concept lattice. The problem is that this concept lattice is usually very large and contains some concepts, which are not interesting for the expert. Because of that, we use the so called crisply generated fuzzy concept lattice (Bělohlávek, Sklenář, & Zacpal, 2005) for displaying the most important information contained in the questionnaire.

TABLE 3
Example of the creation of an ordinal scale of the variable daily number of steps (Pedometer Yamax)

Pedometer Yamax		Context					
Participant	Daily amount of steps		Low active	Somewhat active	Active	Highly active	Extremely active
A	< 7,000	A	1	1	1	1	1
B	7,000–9,999	B	0	1	1	1	1
C	10,000–12,999	C	0	0	1	1	1
D	13,000–15,999	D	0	0	0	1	1
E	≥ 16,000	E	0	0	0	0	1

RESULTS AND DISCUSSION

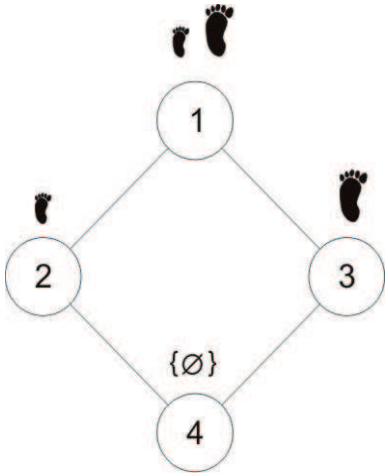
The effect of the selected scale on the final analysis

What effect will the selected scale have on the final lattice? We attempt to provide the answer to this using an example. We will consider the average number of steps per day. The literature has recommended the value of 10,000 steps per day as the health maintaining minimum (Hatano, 1993; Choi, B., Pak, Choi, J., & Choi, E., 2007; Welk et al., 2000; Yamanouchi, Shinozaki, & Chikada, 1995). If we include this recommendation as the basis for our analysis, we will use the nominal scale, which names two attributes: steps – insufficient and steps – sufficient (TABLE 4). This scale can be also understood as a dichotomic scale in the case of an answer to the following question "Does the respondent perform more than 10,000 steps per day?" A dichotomic scale is a special type of nominal scale.

The limited lattice is created when selecting characteristic attributes such as gender – male, gender – female, steps – insufficient and steps-sufficient. For the example, we will analyze only the lattice of men (Fig. 1).

For the analysis, it is important to compare the intents of the individual concepts. It has been proved that higher PA in adults represented by their daily number of steps is associated with a lower Body Mass Index (BMI) (Dwyer et al., 2006; Payn et al., 2008) and with the feeling of having better health (Payn et al., 2008). The following table shows only some attributes of the intents, including BMI (TABLE 5). In Czech adult men, there is a lesser occurrence of obesity (4% : 10%). Obesity (41% : 45%) in individuals showing a higher number of steps per day (≥ 10,000) in comparison to individuals with a daily number of steps below 10,000 (TABLE 5) is apparent.

Fig. 1
Sub lattice of males for two attributes to the variable daily number of steps (Pedometer Yamax)



Legend:

= (gender – male, steps – insufficient)

= (gender – male, steps – sufficient)

TABLE 4
Creation of two attributes for the variable daily number of steps (Pedometer Yamax) – nominal scale

Pedometer Yamax		Context (steps)		
Participant	**Daily amount of steps**		**Insufficient**	**Sufficient**
A	< 10,000	A	1	0
B	≥ 10,000	B	0	1

The division of steps into two parts only (< 10,000 and ≥ 10,000) is, however, from a mathematical and also a kinanthropological point of view very rough (Choi, B., Pak, Choi, J., & Choi, E., 2007; Tudor-Locke & Myers, 2001). Tudor-Locke and Myers (2001) argue that meeting the requirement of 10,000 steps a day is, for many healthy people, not possible. A metaanalysis of the results of 32 studies using pedometers to monitor their daily PA shows that in 8–10 year old children the daily number of steps can be between 12,000–16,000 (less in girls than in boys), in young healthy adults it is 7,000–13,000 steps (less in women than in men). The daily number of steps in healthy older adults is 6,000–8,500 and 3,500–5,500 in people with handicaps or the chronically ill. On the basis of the long-term monitoring of PA using pedometers in adults, Tudor-Locke, Hatano, Pangrazi and Kang (2008) have classified lifestyle in adults according to the number of their steps as follows:

- **< 5,000** steps/day = **sedentary**,
- **5,000–7,499** steps/day = **low active**,
- **7,500–9,999** steps/day = **somewhat active**,
- **≥ 10,000** steps/day = **active**,
- **≥ 12,500** steps/day = **highly active**.

On the basis of this information, we would like to "smoothen" the variable of the daily number of steps into four attributes using the nominal scale of steps – low, steps – insufficient, steps – sufficient and steps – high (TABLE 6).

We will again examine a limited lattice which appears when we choose the characteristic attributes of gender – male, gender – female, steps – low, steps – insufficient, steps – sufficient and steps – high. We will consider only the sub cluster that concerns men (Fig. 2).

If we analyze the lattice using the two attributes of steps (steps – insufficient, steps – sufficient), we will identify basic differences between these two groups. We will do that by comparing the concepts { } and { }.

TABLE 5
Concepts with the attributes of age (years) and Body Mass Index (BMI – $kg \cdot m^{-2}$) for the variable daily number of steps – nominal two attributes scale

Concepts	Age (years)					Level of body weight (classified according to BMI)			
	15–24 years	2–34 years	35–44 years	45–54 years	55–65 years	underweight (< 18.5)	normal weight (18.5–24.9)	overweight (25–29.9)	obesity (≥ 30)
{, }	0.18	0.34	0.22	0.17	0.07	0.03	0.42	0.41	0.04
{ }	0.18	0.40	0.22	0.17	0.13	0.04	0.42	0.45	0.10
{ }	0.25	0.34	0.15	0.18	0.07	0.03	0.52	0.41	0.04

TABLE 6
Creation of four attributes for the variable daily number of steps (Pedometer Yamax) – nominal scale

Pedometer Yamax		Contex (steps)				
Participant	Daily amount of steps		Low	Insufficient	Sufficient	High
A	< 6,000	A	1	0	0	0
B	6,000–9,999	B	0	1	0	0
C	10,000–13,999	C	0	0	1	0
D	≥ 14,000	D	0	0	0	1

For example, in attributes that concern BMI, no significant differences are apparent. The same procedure can be applied to the lattice which we obtained by using four attributes of steps (steps – low, steps – insufficient, steps – sufficient and steps – high). We will obtain similar results by comparing the concepts of {, } and { , }. If we examine the lattice and attempt a more detailed examination, we will identify more apparent differences between BMI in individual groups of respondents with different attributes of steps by comparing the concepts of { }, { }, { }, { }. The following table shows these concepts with selected attributes (TABLE 7).

Generally, we can argue that the rougher the scale is, the lesser the lattice we obtain, and thus the analysis will be simpler. On the other hand, by using a "smoother" scale, we will obtain a more detailed analysis, however we will work with a lattice which is more difficult. The most efficient procedure seems to be the monitoring of changes in the selected attributes by the gradual smoothening of the original "rough" scale. The smoothening needs to stop when the aggregated attributes consist of too few respondents (10–15). In a lower number of respondents, analysis is not efficient.

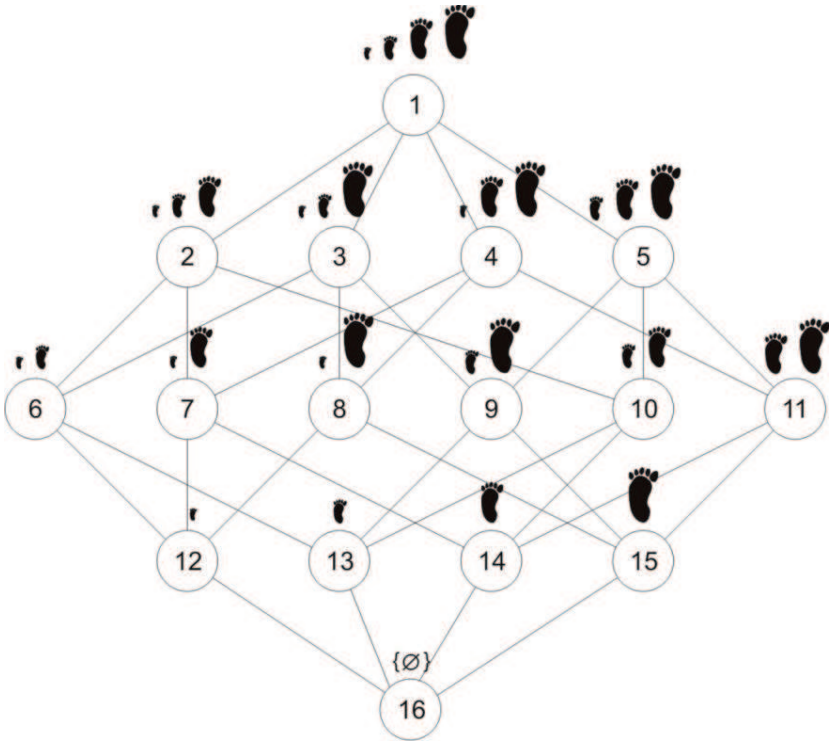
The effect of the selected scale on the final analysis

In the case of variables where more scales can be applied, the choice of the appropriate scale needs to be considered. For example, we consider the number of steps per day in a respondent. We can choose either the nominal or the ordinal scale. We use the nominal scale from the previous chapter (TABLE 6). The ordinal scale is described in the following table (TABLE 8).

Note: The example does not show a typical ordinal scale, but a special type of such a scale called biordinal. This type of scale describes contradictory concepts. In this case they are insufficient and sufficient daily amount of steps.

As characteristic attributes we will again use gender (gender – male, gender – female) and BMI (BMI – underweight, BMI – normal weight, BMI – overweight, BMI – obesity). The structure of both fuzzy conceptual lattices will be the same because the same characteristic attributes are selected (Fig. 3). Fig. 3 presents a sub lattice for aggregated objects with a characteristic attribute of gender – male.

Fig. 2
Sublattice of males for four attributes to the variable daily number of steps (Pedometer Yamax)



Legend:

= (gender – male, steps – low), = (gender – male, steps – insufficient),

= (gender – male, steps – sufficient), = (gender – male, steps – high)

The degrees of the truth level of attributes will be different due to the different scales applied. The comparison of these attributes is shown in the following table (TABLE 9).

The comparison of the degrees of the truth level created using nominal and ordinal scales shows the different values of attributes of steps – insufficient and steps – sufficient. The difference is caused by the fact that in ordinal scales, the attribute of steps insufficient involves also the attribute of steps-low and on the other hand the attribute of steps – sufficient involves also attribute steps – high. In an ordinal scale we thus obtain a total percentage of all respondents who show either a sufficient or an insufficient number of steps. When analyzing the entire lattice, this seems to be more efficient since we obtain a comprehensive view of these two groups which we can further describe more in detail by assessing groups with a "more extreme" number of steps (steps – low, steps – high). We can therefore conclude that using the ordinal scale in such a case is more efficient. However, in some situations using the nominal scale is more efficient, for example, in situations when we are interested in particular intervals.

CONCLUSIONS

We have shown some examples of using different scales and their effects on the results while applying Formal Conceptual Analysis. We can conclude that only due to an appropriate choice of "smoothness" and the scale, can we obtain precise results. The expert's experience and expertise in the field of physical activity plays an essential role. Yet, choosing the correct scale and the smoothness of the scale, especially in highly variable variables such as a daily number of steps is also important.

Data processing without the appropriate software is not possible these days. In the case where FCA is applied, the Lattice Navigator program (Radvanský & Sklenář, 2007) to process the data is useful. The scales can be easily changed and adjusted in this program. We can examine the final clusters and compare "interesting" concepts.

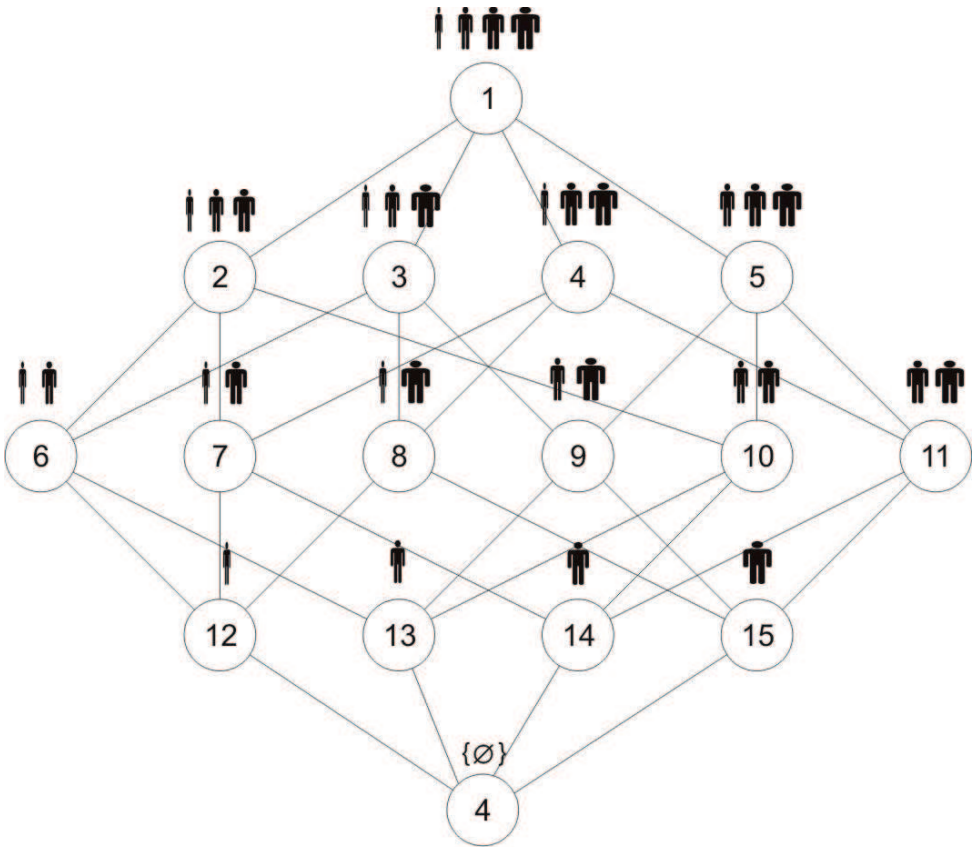
TABLE 7
Concepts with the attributes of age (years) and Body Mass Index (BMI – $kg \cdot m^{-2}$) for the variable daily number of steps – nominal four attributes scale

Concepts	Age					Level of body weight (classified according to BMI)			
	15–24 years	25–34 years	35–44 years	45–54 years	55–65 years	underweight (< 18.5)	normal weight (18.5–24.9)	overweight (25–29.9)	obesity (≥ 30)
{,,,}	0.08	0.34	0.11	0.08	0.07		0.33	0.40	0.01
{,,}	0.08	0.35	0.11	0.08	0.07		0.33	0.42	0.01
{,,}	0.08	0.34	0.11	0.08	0.08		0.33	0.40	0.08
{,,}	0.08	0.34	0.15	0.08	0.07		0.33	0.40	0.01
{,,}	0.19	0.34	0.11	0.15	0.07	0.01	0.44	0.40	0.01
{,,}	0.08	0.39	0.11	0,08	0.11		0.33	0.44	0.08
{,}	0.08	0.35	0.15	0.08	0.07		0.33	0.42	0.01
{,}	0.08	0.34	0.16	0.08	0.08		0.33	0.40	0.08
{,}	0.19	0.34	0.11	0.18	0.08	0.01	0.44	0.40	0.08
{,}	0.20	0.35	0.11	0.15	0.07	0.04	0.44	0.42	0.01
{,}	0.19	0.34	0.15	0.15	0.07	0.01	0.51	0.40	0.01
{}	0.08	0.42	0.17	0.08	0.25		0.33	0.50	0.17
{}	0.20	0.39	0.11	0.18	0.11	0.04	0.44	0.44	0.08
{}	0.28	0.35	0.15	0.15	0.07	0.04	0.53	0.42	0.01
{}	0.19	0.34	0.16	0.23	0.08	0.01	0.51	0.40	0.08

TABLE 8
Creation of four attributes for the variable daily number of steps (Pedometer Yamax) – ordinal scale

Pedometer Yamax		Contex (steps)				
Participant	Daily amount of steps		Low	Insufficient	Sufficient	High
A	< 6,000	A	1	1	0	0
B	6,000–9,999	B	0	1	0	0
C	10,000–13,999	C	0	0	1	0
D	≥ 14,000	D	0	0	1	1

Fig. 3
Sublattice of males for nominal and bi-ordinal scale



Legend:

= *(gender – male, BMI – underweight),* = *(gender – male, BMI – normal weight),*

= *(gender – male, BMI – overweight),* = *(gender – male, BMI – obesity)*

ACKNOWLEDGMENT

The study has been supported by the research grant from the Ministry of Education, Youth and Sports of the Czech Republic (No. MSM 6198959221) "Physical Activity and Inactivity of the Inhabitants of the Czech Republic in the Context of Behavioral Changes".

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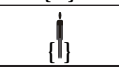
TABLE 9
Comparison of the degrees of the truth level of attributes created using nominal and ordinal scales

	Nominal scale				Ordinal scale			
Concepts	**Low**	**Insufficient**	**Sufficient**	**High**	**Low**	**Insufficient**	**Sufficient**	**High**
		0.23	0.07	0.11		0.26	0.47	0.11
	0.03	0.23	0.07	0.27	0.03	0.26	0.47	0.27
		0.23	0.07	0.11		0.26	0.47	0.11
		0.27	0.07	0.11		0.32	0.47	0.11
		0.23	0.41	0.11		0.26	0.67	0.11
	0.05	0.27	0.07	0.27	0.05	0.32	0.47	0.27
	0.03	0.23	0.41	0.27	0.03	0.26	0.68	0.27
	0.03	0.23	0.07	0.29	0.03	0.26	0.68	0.27
		0.33	0.07	0.11		0.33	0.47	0.11
		0.23	0.45	0.11		0.26	0.67	0.11
		0.27	0.41	0.11		0.32	0.67	0.11
	0.13	0.40	0.07	0.40	0.13	0.53	0.47	0.40
	0.05	0.27	0.41	0.27	0.05	0.32	0.68	0.27
	0.03	0.23	0.45	0.29	0.03	0.26	0.74	0.29
		0.33	0.56	0.11		0.33	0.67	0.11

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APLIKACE FORMÁLNÍ KONCEPTUÁLNÍ ANALÝZY A DŮLEŽITOST VÝBĚRU ŠKÁLY PŘI HODNOCENÍ DAT O POHYBOVÉ AKTIVITĚ VE VZTAHU K BODY MASS INDEXU

(Souhrn anglického textu)

VÝCHODISKA: Nenahraditelnost pohybové aktivity (PA) ke zdravému a pohybově aktivnímu životnímu stylu je široce akceptována a zdůrazňována. Stále se však hledá zdravotně optimální míra její každodenní realizace a způsob její přesné kvantifikace a srozumitelné interpretace. Možným prostředkem k vyhodnocování a interpretaci úrovně prováděné PA a jejího vztahu k osobním datům je Formální konceptuální analýza (FCA).

CÍLE: Hlavním cílem této studie je představit metodu Formální konceptuální analýzy na vyhodnocení konkrétního příkladu dat z ANEWS dotazníku a denního počtu kroků z pedometru Yamax. Dílčím cílem je pak poukázat na správný výběr škály při jejím používání.

METODIKA: Metoda FCA je představena na datech z ANEWS dotazníku a denního počtu kroků z pedometru Yamax SW-701 u randomizovaného souboru 18–69letých mužů (n = 273) z České republiky.

VÝSLEDKY: Při použití různých druhů škály (nominální nebo ordinální) zjišťujeme odlišné skupinové výsledky. V případě denního počtu kroků je vhodnější zvolit ordinální škálu, neboť vytváříme atributy, které lze seřazovat (např. nižší počet kroků je současně počet nedostatečný).

ZÁVĚRY: Volba hrubší škály vede k jednoduššímu svazu s možností komplexnějšího pohledu na sledované atributy. Naproti tomu postupné zjemňování škály vede ke složitějším svazům a tedy náročnější analýze, získáváme však podrobnější výsledky. Formální konceptuální analýza klade vyšší nároky na odbornost uživatele (výzkumníka) než „klasická" testovací statistika, umožňuje však plastičtější vhled do zkoumané problematiky.

Klíčová slova: nominální a ordinální škála, fuzzy, agregovaný objekt, svaz, kroky, muži.

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