



Pharmaceutical consumption patterns in the South Baltic Region – Comparing Sweden, Germany, Poland and Lithuania

Modelling of regional pharmaceutical consumption patterns is a method to quantify the loads of pharmaceuticals that enter wastewater treatment plants (WWTPs) via household sewage systems. In MORPHEUS, the regional consumption data from four coastal regions in Sweden, Germany, Poland and Lithuania was collected wherein different formats of yearly statistics are available. The regional statistics are either based on sales data of wholesalers/pharmacies or on data from health care institutions.

In Poland and Lithuania, wholesale data is represented in numbers of reimbursed packages according to so-called EAN codes (bar codes). Combined with specific product information such as pharmaceutical content (milligram per pill and number of pills), the total consumed mass load can be calculated. In contrast, German and Swedish data are published by health care institutions and administrative authorities based on prescriptions in the statistical unit DDD (daily defined doses). For such a format, the WHO Collaborating Centre for Drug Statistics Methodology (WHOCC), provides a list of conversion factors to determine the corresponding total consumed mass loads. Finally, the loads are divided by the considered number of inhabitants in order to generate comparative but region-specific values as yearly intake loads per inhabitant [mg/inh.].

Comparison of the four model areas

The calculations provide an initial idea of the main differences and similarities in consumption. Germany and Sweden are more comparable with one another, as are Lithuania and Poland where the health care systems result in similar data formats and availabilities; prescriptions vs. refunding, respectively. Nevertheless,

in all four countries, similar trends were found for e.g. the antidiabetic pharmaceutical Metformin with intake loads ranging from 9,000 mg/inh. (Lithuania) to almost 30,000 mg/inh. (Germany) in 2015. On the contrary, the antibiotic Clarithromycin is used much more in Germany and Poland than in Sweden and Lithuania. It is important to mention here that the project focused on selected pharmaceuticals. The potential for replacing pharmaceuticals, such as antibiotics, is not necessarily covered by this analysis. Nevertheless, the main regional differences can be summarized in four key findings.

Key finding 1: Country-specific consumption

Consumption of individual pharmaceuticals is country-specific. In all model areas, heart medicines are prescribed or refunded. Metoprolol is the highest consumed beta-blocking substance out of three investigated. The yearly intake in Sweden and Germany is distinctly higher than 1400 mg/inh., while Poland and Lithuania do not exceed 100 and 620 mg/inh., respectively (Fig. 1). This will affect the burden on the WWTPs and finally the environment.

Key finding 2: Seasonal variation of consumption

Consumption of some medicines varies with season, while others do not. The intake load of Metformin for treating diabetes is nearly steady, with a variation of about 5.5% between the monthly intake loads. The intake loads of the antibiotic Amoxicillin is much higher in the winter/spring season than in the summer season. The results seem to be reasonable since the risk of bacterial infections, colds etc. is much higher in winter and spring than in summer.

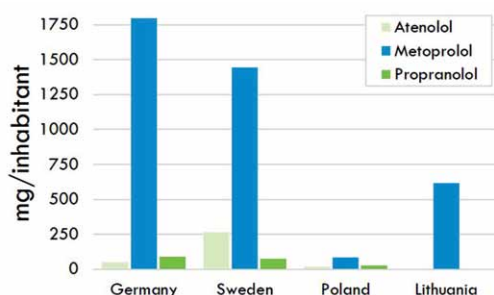


Figure 1. Total yearly intake loads of the heart medicines Atenolol, Metoprolol and Propranolol in mg/inh., data from 2015.

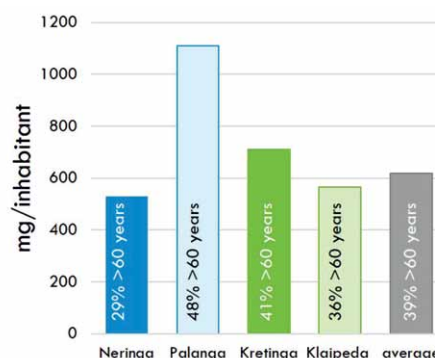


Figure 2. Total monthly intake loads of the heart medicine Metoprolol in mg/inh., data from Lithuania, 2015.

Key finding 3: Age-dependency of consumption

Consumption of some compounds differs between cities and rural areas probably due to differing age structures. For example, Metoprolol consumption per inhabitant is highest in Palanga, a seaside resort in Lithuania. Metoprolol is a beta-blocking substance (heart medicine) which is mostly consumed by elderly people. This correlates with the demographic structure of Palanga, which has a higher share of elderly inhabitants (>60 years) than other investigated municipalities. (Fig. 2)

Key-finding 4: Various distribution sites of pharmaceuticals

For Swedish and German data, a comparison of different distributing sites of pharmaceuticals was possible. This included prescriptions, hospitals and private purchases without prescription, namely "over the counter sales" (OTC). Overall, a relatively low contribution from hospitals was indicated for 15 out of more than 2,300 pharmaceuticals. The antibiotic Ciprofloxacin is frequently used in hospitals but is still usually distributed by pharmacies/prescriptions in both countries. Hence, a removal of pharmaceuticals only from

hospital wastewater would not sufficiently reduce the load in wastewater. Due to outpatient intake, actions at municipal WWTPs are required to counteract increasing antibiotic resistance. In general, painkillers such as Ibuprofen are largely consumed via OTC. This means that a reduction of loads and resulting burden on the environment requires a fundamental rethink of individual applications of pharmaceuticals. Colds, headaches and feelings of discomfort might in some cases be treated with proven home remedies causing no side effects to the environment (Fig. 3).

Modelled consumption patterns can predict the concentrations of pharmaceutical substances entering WWTPs

The results from the MORPHEUS project have shown that the estimated loads derived from modelled consumption patterns are comparable to the loads derived from measured concentrations for many of the monitored pharmaceutical substances.

In summary, it can be stated that consumption of pharmaceuticals differs between countries, regions and even cities. A comparative analysis conducted in the MORPHEUS project confirmed that distribution patterns depend on doctors' prescriptions, the season, and age of the population. A proportion of each consumed medicine end up in WWTPs and, since many of them are not removed sufficiently with current treatment technologies, they eventually find their way into rivers, lakes and the South Baltic Sea. Investigating the local consumption patterns is recommended to understand which pharmaceuticals are most relevant in which region. Combining this knowledge with chemical analysis of pharmaceuticals in WWTPs and receiving water bodies, will aid prioritization processes and ensure wiser investments in advanced treatment technologies to remove relevant pharmaceuticals from the local wastewater and the aquatic environment. The first step we can all make however, is to use and dispose of pharmaceuticals wisely for our own sake and the sake of the environment.

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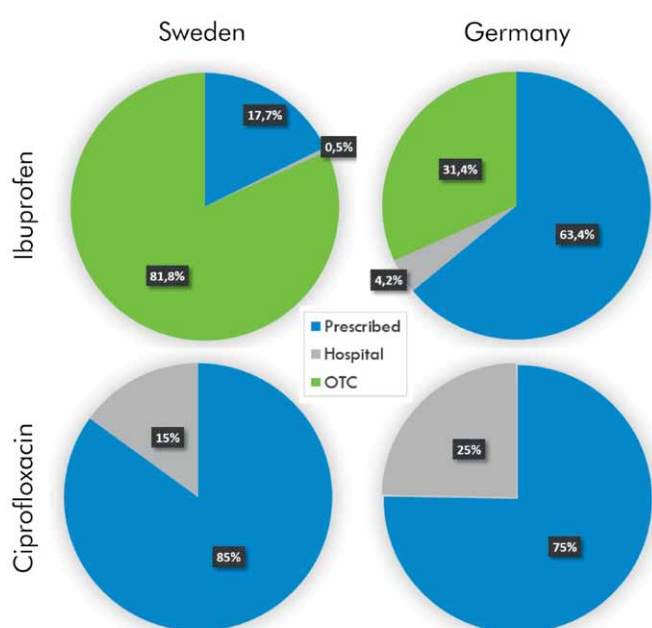


Figure 3 Comparison of different distributing sites of pharmaceuticals (prescriptions, hospitals and over the counter sales (OTC)) for Ibuprofen (top) and Ciprofloxacin (bottom) in Sweden (left) and Germany).