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Cause-Specific Mortality Trends in The Netherlands, 1875–1992: A Formal Analysis of the Epidemiologic Transition

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Background. The objective of this study is to produce a detailed yet robust description of the epidemiologic transition in The Netherlands.

Methods. National mortality data on sex, age, cause of death and calendar year (1875–1992) were extracted from official publications. For the entire period, 27 causes of death could be distinguished, while 65 causes (nested within the 27) could be studied from 1901 onwards. Cluster analysis was used to determine groups of causes of death with similar trend curves over a period of time with respect to age- and sex-standardized mortality rates.

Results. With respect to the 27 causes, three important clusters were found: (1) infectious diseases which declined rapidly in the late 19th century (e.g. typhoid fever), (2) infectious diseases which showed a less precipitous decline (e.g. respiratory tuberculosis), and (3) non-infectious diseases which showed an increasing trend during most of the period 1875–1992 (e.g. cancer). The 65 causes provided more detail. Seven important clusters were found: four consisted mainly of infectious diseases, including a new cluster that declined rapidly after the Second World War (WW2) (e.g. acute bronchitis/influenza) and a new cluster showing an increasing trend in the 1920s and 1930s before declining in the years thereafter (e.g. appendicitis). Three clusters mainly contained non-infectious diseases, including a new one that declined from 1900 onwards (e.g. cancer of the stomach) and a new one that increased until WW2 but declined thereafter (e.g. chronic rheumatic heart disease).

Conclusions. The results suggest that the conventional interpretation of the epidemiologic transition, which assumes a uniform decline of infectious diseases and a uniform increase of non-infectious diseases, needs to be modified.

Keywords: mortality, trend, causes of death, epidemiologic transition, cluster analysis

The epidemiologic transition theory, as formulated by Omran, describes a shift from infectious to degenerative and man-made diseases in populations throughout time. The age of pestilence and famine, in which mortality is high and fluctuating due to epidemics of infectious diseases is followed by the age of receding pandemics in which infectious diseases are declining, although they are still important causes of death. In the last age, the age of degenerative and man-made diseases, cardiovascular diseases, cancer, diabetes and other metabolic disorders and diseases introduced by man (such as accidents), predominate as causes of death. The epidemiologic transition has been observed in many countries although time frames are different.[1–4]

Omran and others have described the epidemiologic transition on the basis of broad cause-of-death categories and rather informal analyses, such as the comparison over time of the rank order of causes of death or the contribution of causes of death to all-cause mortality.[5–8] In this paper we will describe the epidemiologic transition in The Netherlands using a more refined cause-of-death classification and a formal statistical method. The aim of this study is to produce a detailed yet robust description of the epidemiologic transition which will form a good starting point for explanatory studies.

A more detailed analysis of causes of death is likely to be more useful in the understanding of the epidemiologic transition than studies that are based on broad cause-of-death categories. In addition, a formal statistical method (cluster analysis), is likely to produce less

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subjective and more robust results than those gained from informal analyses. The cluster analysis is applied to cause-specific mortality trends because time trends are more useful for explaining the epidemiologic transition than, for example, changes throughout time in the contribution of causes of death to all-cause mortality. This paper presents clusters of causes of death with the same trend over a period of time, irrespective of mortality rates. In other words, clusters consist of causes of death that decline and increase together throughout time. The results of the cluster analysis will not only provide a detailed description of the pattern of cause-specific mortality trends that underlie the all-cause mortality trend, but they might also contribute to a better understanding of the epidemiologic transition by discussing the results in terms of common determinants of the causes of death within the clusters.

DATA AND METHODS

Data

Absolute numbers of deaths with respect to sex, age and cause of death were used for the years 1901–1992, which were published by the Dutch Central Bureau for Statistics. Data for the period 1875–1900 were derived from quinquennial figures published by the Dutch Home Office.

Nested Classification

The causes of death had to be reclassified in order to create nosologically continuous groups of causes of death, because the period 1875–1992 covered a very concise 19th century classification as well as nine revisions of the International Classification of Diseases and Causes of Death (ICD). Causes of death in the new classification were reclassified on the basis of the old classification. Because this results in a classification which is very similar to the concise 19th century classification, a nested classification that consists of three aggregation levels of causes of death was developed in order to maintain the level of detail. The construction and validation of this nested classification has been described elsewhere.[9] The study detailed here uses two aggregation levels of causes of death (27 and 65 causes) which could be studied over two different time periods (1875–1992 and 1901–1992 respectively). The causes of death used in this study and the most recent ICD codes have been included in the Appendix.

Most attention will focus on the 65-causes level, because infectious as well as non-infectious causes were equally represented at this level. The 27-causes level, which could be studied for the entire period 1875–1992, is particularly informative in terms of the trends of infectious diseases during the 19th century.

Standardization

Standardized mortality rates for age and sex were calculated (direct standardization) to correct for the effect of the changing age and sex distribution on mortality. Eight age groups were used in the standardization procedure: 0, 1–4, 5–14, 15–19, 20–49, 50–64, 65–79 and $\geqslant$80 years, which was the greatest common denominator of all age subdivisions used in the period 1875–1992. The reference population was the average population in the period 1901–1992. This standard was used for the period 1875–1992 as well as for the period 1901–1992.

Cluster Analysis

This study aimed to determine which causes of death declined and increased together over a period of time. This means that we were not interested in the general level of causes of death, but in the shape of their trend curves. Therefore, standardized mortality rates for age and sex were standardized to equal means over the period under study for each cause of death.

For many causes of death there were strong interruptions in trends due to the influenza epidemic of 1918 and the Second World War (WW2). Because we were interested in the long-term developments of mortality irrespective of interruptions caused by specific extraneous events such as war, and because important interruptions in the trend would dominate the results of the cluster analysis the years 1918 and 1940–1946 were excluded from the analyses.

Because of the heuristic nature of cluster methods we used two different methods, each of which aims to minimize the within-cluster-sum-of-squares, i.e. to optimize according to the least squares principle. One is the well-known agglomerative hierarchic cluster method or ‘Ward’s analysis’,[10] the other is a less-known divisive cluster method ‘Orbaclan’, based on bisecting principal component axes of subsequent clusters.[11] Both methods were followed by relocation procedures, thereby using the least squares criterion again. Relocation did not lead to many changes, which indicates stable solutions. Because the results of both methods were highly comparable we will only present the results of Ward’s analysis. The number of clusters that were presented as the end result was determined on the basis of the agglomeration tree.[10]

Sex differentials were studied by relocating the female data using the outcome of the male cluster analysis and vice versa. There were hardly any differences between the clusters for males and females, so the results are not presented according to sex.

TABLE 1 *Clustering of 27 causes of death in the period 1875–1992*

Cluster 1: mainly infectious diseases: sharp decline late 19th century, further decline during 20th century typhoid fever, scarlet fever, measles, scurvy
Cluster 2: mainly infectious diseases: steady decline during late 19th century and 20th century 'debility etc.',[a] diseases of the nervous system, respiratory tuberculosis, diphtheria, whooping cough, acute respiratory diseases, chronic respiratory diseases, acute digestive diseases, chronic diseases of the digestive system, diseases of the genito-urinary system, puerperal diseases (exc. puerperal fever), puerperal fever, unknown and ill-defined causes of death
Cluster 3: non-infectious diseases: increase during late 19th and 20th century congenital anomalies, cancer, cerebrovascular disease, diabetes mellitus, diseases of circulatory system (exc. cerebrovascular disease), external causes of death (exc. suicide), suicide
Cluster 4: rapid decline late 19th century malaria
Cluster 5: rapid decline late 19th century with high peaks in 1880 and 1890 smallpox
Cluster 6: rapid decline late 19th century, epidemic 1888–1892 cholera

[a] This category consists of debility (mainly perinatal causes of death and old age), some types of tuberculosis, scrofula, rachitis, diseases of the skin, abscess, ulcer, gangrene, pyeamia, heamorrhage, continuous fever.

RESULTS

The results of the cluster analysis are represented in the Tables and Figures. The y-axis in the figures represents cluster averages based on mortality rates standardized to equal means (= 1) for the whole period. Clusters consisting of only one or two causes are omitted from the figures for practical reasons.

Twenty-Seven Causes, 1875–1992

A division of the 27 causes into six clusters provided the best description of differences and commonalities in patterns of changes over the period of time (Table 1 and Figure 1). The cluster with, among others, typhoid fever and scarlet fever declined during the whole period under study but most sharply at the end of the 19th century (Table and Figure 1, cluster 1). Another cluster that consisted mainly of other infectious diseases also declined during the whole period under study but showed a more even decline compared to cluster 1 (Table and Figure 1, cluster 2). The cluster which shows an increasing trend curve during the period under study consists of all the causes of death which are currently important in developed countries e.g. cancer and cardiovascular diseases (Table 1 and Figure 1, cluster 3). Three causes of death are distinguished as separate clusters in this analysis i.e. cholera, malaria and smallpox (Table 1, clusters 4–6). Malaria and smallpox had nearly disappeared by the end of the 19th century. The few cases that occurred in the late 19th and early 20th century resulted in enormous peaks in the shape of the trend curve of those causes. Cholera showed a similar trend as cluster 1 (typhoid fever etc.) but the epidemic of the years 1888–1892 caused an enormous peak in the trend resulting in cholera being a separate cluster.

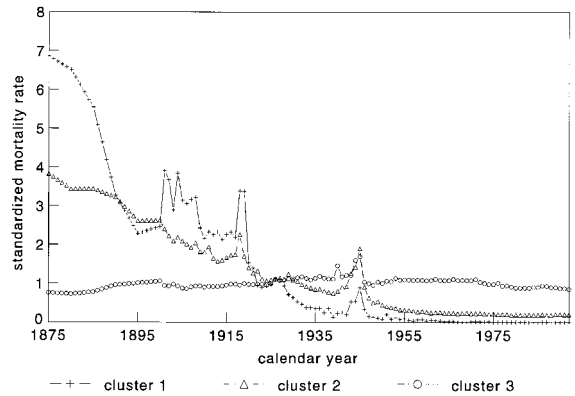

FIGURE 1 *Trends of the clusters as described for 27 causes of death*

The y-axis represents cluster averages of cause-specific age-standardized mortality rates standardized to equal means (= 1) over the years under study. For an explanation of the content of the clusters see Table 1.

Sixty-Five Causes, 1901–1992

The analysis of 65 causes gives a more detailed insight into the results of the 27 causes of death clustering. The 65 causes are presented as 10 clusters with different

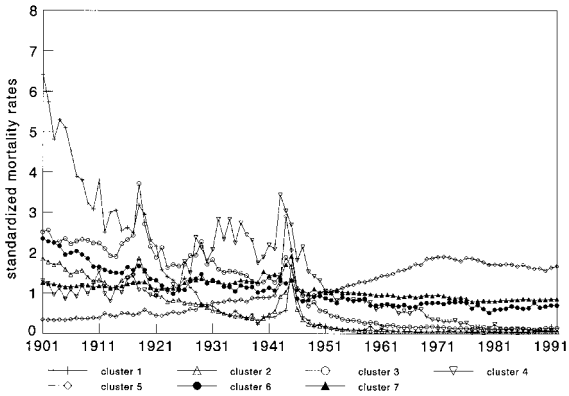

FIGURE 2 *Trends of the clusters as described for 65 causes of death*

The y-axis represents cluster averages of cause-specific age-standardized mortality rates standardized to equal means (= 1) over the years under study. For an explanation of the content of the cluster see Table 2.

trends (Table and Figure 2) of which four clusters predominantly consisted of infectious causes of death (clusters 1–4) and three clusters of non-infectious causes of death (cluster 5–7). In addition, there were three clusters with only one or two causes of death (smallpox, cholera and anthrax, poliomyelitis; clusters 8–10). Cluster 1 is more or less comparable to cluster 1 of the 27 causes clustering; the clusters 2, 3 and 4 are more or less comparable to cluster 2, clusters 5 to 7 are more or less comparable to cluster 3, and clusters 8 and 9 are more or less comparable to clusters 5 and 6 of the 27 causes clustering.

Three clusters that consist of infectious causes of death (clusters 1 to 3) differ with respect to the amount of *decline* in the early 20th century. Cluster 1 (typhoid fever etc.) declined throughout the whole of the 20th century, but most rapidly at the beginning. Cluster 2 (whooping cough etc.) showed a more even decline during the 20th century compared to cluster 1. Cluster 3 (acute bronchitis etc.) hardly declined in the early 20th century, but showed a rapid decline after WW2. Cluster 4 which also consisted of infectious diseases (appendicitis etc.) showed, on the contrary, a strong *increase* in the second and third decade of the 20th century followed by a decline after WW2.

As far as the non-infectious-diseases clusters are concerned, cluster 5 (breast cancer etc.) is the only cluster which shows an increase during most of the 20th century. Cluster 6 (stomach cancer etc.) declined relatively fast in the first two decades of this century and has continued to decline since. Cluster 7 (intestinal cancer etc.) differed from cluster 6 by a slight increase instead of a decline in the first half of this century.

Stages in the Epidemiologic Transition

We identified several stages in the epidemiologic transition, thereby using the results of the cluster analysis. The years 1918 and 1940–1946 are not taken into consideration, because these years were not included in the cluster analysis. A new stage was assumed to begin when an important change in the trend of one or more clusters occurred. A first stage, 1875–1900, is characterized by an enormous decline in typhoid fever, scarlet fever, scurvy and, to a lesser extent, measles (Figure 1, cluster 1). The period 1901–1920 is defined as a second stage in which the decline of the above-mentioned causes of death became less progressive, although the decline was still considerable compared to other clusters (Figure 1, cluster 1 and Figure 2, cluster 1). The next stage, 1921–WW2, is characterized by an increase in certain infectious diseases e.g. appendicitis (Figure 2, cluster 4) and a less progressive decline of a number of non-infectious diseases e.g. neoplasms of stomach/oesophagus/liver/gallbladder (Figure 2, cluster 6). There also seems to be a more rapid decline of airborne infectious diseases (Figure 2, cluster 2). A fourth stage, WW2–1970, is characterized by the strong increase in IHD, several types of cancer and traffic accidents (Figure 2, cluster 5), a rapid decline of the cluster consisting of, among others, acute bronchitis/influenza (Figure 2, cluster 3) and the decline of the cluster of infectious diseases which had been on the increase (Figure 2, cluster 4). The decline of the cluster that includes IHD, cancer and traffic accidents in 1970 marks the last stage (Figure 2, cluster 5). This last stage corresponds with the extension of Omran's description of the epidemiologic transition with a fourth stage by several researchers.[12,13]

DISCUSSION

Methodological Aspects

The results provide global trends and should not be interpreted as detailed information on specific causes of death. Cause-specific trends, which differed only for a small part of the total period under study, were put in the same cluster. For example, IHD and traffic accidents, which increased until 1970 but declined afterwards, were put in the same cluster as breast cancer and 'other cancers' (including lung cancer), which continued to increase after 1970. Thus IHD and traffic accidents were not recognized as a separate cluster but were joined with the least differential groups.

Furthermore, the results of the cluster analysis are dependent on the starting point of the period under study. Scarlet fever and typhoid fever, for example, were in the same cluster in the results of the analysis for the period 1875–1992. In the analysis for the period 1901–1992 scarlet fever was put in a cluster which declined less rapidly compared to the cluster that consisted of typhoid fever. Both causes of death declined noteably in the last decades of the 19th century. This similarity in trends was more important than differences in later years. However, in the analysis from 1901 onwards, this tremendous decline in the 19th century was not within the scope of the analysis anymore and differences in the shape of the remaining trend became important.

Because we were interested in long-term developments of cause-specific mortality, interruptions due to specific extraneous events such as the influenza epidemic in 1918 and the years of WW2 (1940–1946), which would dominate the results of the cluster analysis, were not included in the analyses. If the years 1918 and 1940–1946 are included in the analysis, influenza would be a separate cluster, due to the high peak in 1918, and diphtheria and homicide would form a cluster, because of the high peaks in mortality from those causes of death in WW2 (results not shown in this paper).

A final remark on the cluster analysis concerns the decision about how many clusters best represent the data i.e. the differences and commonalities in cause-specific time trends. The number of clusters is determined on the basis of the increase in the value of the distance measure between clusters as given in the agglomeration tree. Agglomeration is usually stopped as soon as the increase in distance measure between the clusters that are merged in a next agglomeration step becomes large.[10] In the case of 27 causes of death (cf. Table 1), this led to a division of the cause-specific mortality trends into six clusters. In the agglomeration stage of five clusters, the causes of death in clusters 1 and 2 were in the same cluster (cf. Table 1). There is however a clear distinction in the trend of both clusters: cluster 1 declined sharply in the late 19th century compared to cluster 2 (cf. Figure 1). A division into 7 clusters would lead to a separate cluster of typhoid fever and scarlet fever. The trend curves of those causes of death are, however, similar to the other causes of death in cluster 1 (cf. Table 1). For the 65 causes of death (cf. Table 2), it was more difficult to determine the point in the agglomeration tree at which the increase in distance measure became large. In the agglomeration stage before the division into 10 clusters, the causes of death in clusters 6 and 7 were in the same cluster. This obscures the fact that cluster 6 represents non-infectious causes of death showing a declining trend throughout the 20th century. In the agglomeration stage after the division into 10 clusters, cholera and anthrax became separate clusters. This did not, however, lead to a better understanding of the differences and commonalities in cause-specific mortality trend curves.

In addition to characteristics of the cluster analysis itself there are also characteristics of the data that might have affected the results. Firstly, the age groups that were used for the calculation of standardized mortality rates were rather broad, especially for older ages. This might have biased trends of causes of death at older ages. However, to affect the results of the cluster analysis, the trend should have changed considerably in order to end up in another cluster; this does not seem to have happened.

Secondly, the introduction of new cause-of-death classifications, new coding habits and improvements in diagnosis might have affected specific cause-of-death trends and, consequently, the results of the cluster analysis. We have tried to minimize the effects of new classifications and coding habits by conducting an extensive reclassification procedure.[9] However, the introduction of ICD-6 in 1950 might have influenced the inclusion of cerebrovascular accident (CVA) in cluster 7 instead of cluster 6 (cf. Table 2). CVA mortality had been declining slowly since 1901, but an increase of CVA mortality, probably as a result of changing coding habits, took place in 1950 followed by a renewed rapid decline. We do not expect further serious influences of the introduction of new ICD-revisions on the results of the cluster analysis. It is difficult to deal with the effects of improved diagnosis. The presence of ill-defined causes of death in a declining cluster (cf. Table 2 and Figure 2, cluster 2) might indicate that diagnosis and notification improved in the early 20th century. The most direct way to solve this problem would have been to restrict the time frame of the study to, for instance, 1930–1992. In this case, we would have lost a lot of information on the early period of the epidemiologic transition such as, for example, the strong decline of typhoid fever in the late 19th and early 20th century. Improvements in diagnosis could temporarily change the level and trend of mortality of certain causes of death. Significant changes in the trend curve are however needed to influence the result of the cluster analysis. The IHD trend curve, for example, probably shows a stronger increase in the 1930s than the real increase due to improvements in diagnosis by that time. However, the IHD trend curve is characterized by a strong increase up to 1970 and a decrease afterwards. This overall IHD pattern will still hold even if the increase in the early 20th century might not have been as strong as shown by the data.

TABLE 2 *Clustering of 65 causes of death in the period 1901–1992*

Cluster 1: mainly infectious diseases: rapid decline early 20th century typhoid fever, malaria, measles, scurvy, diarrhoea/dysentery/enteritis, convulsions
Cluster 2: mainly infectious diseases: moderate decline early 20th century whooping cough, diphtheria, respiratory tuberculosis, tuberculosis of meninges and central nervous system, tuberculosis of intestines/peritoneum/mesenteric glands, disseminated tuberculosis/tuberculosis of other organs, encephalitis/meningitis, scarlet fever, peritonitis, acute nephritis, unknown and ill-defined causes of death
Cluster 3: mainly infectious diseases: most rapid decline after WW2 acute bronchitis/influenza, erysipelas, syphilis, rheumatic fever/chorea, senility/dementia, pneumonia, empyema/pleurisy, chronic nephritis/other diseases of kidney, puerperal fever, complications of pregnancy/childbirth /puerperium (exc. puerperal fever), septicaemia /pyaemia
Cluster 4: mainly infectious diseases: increase in the 1920s and 1930s appendicitis, diseases of prostate and other male genital organs, diseases of female genital organs, venereal infections (exc. syphilis), diseases of the ear (inc. otitis media)
Cluster 5: non-infectious diseases: rapid increase until 1970s malignant neoplasm of breast, malignant neoplasm of other organs, ischaemic heart disease, homicide, traffic accidents
Cluster 6: mainly non-infectious diseases: decline during the 20th century malignant neoplasm of stomach/oesophagus/liver/gallbladder, diseases of adrenal glands, alcoholic psychosis/alcoholism, diseases of larynx/pharynx /nasal cavity/oral cavity, chronic bronchitis /emphysema/asthma/other respiratory diseases (COPD), diseases of oesophagus, perinatal causes of death
Cluster 7: mainly non-infectious diseases: slight increase until WW2 and a decline afterwards malignant neoplasm of small intestines/large intestines/rectum/peritoneum, malignant neoplasm of skin, diseases of the musculoskeletal system and connective tissue/vitamin D deficiency/gout, diabetes mellitus, hereditary and familial diseases of nervous system/other diseases of the nervous system (exc. parkinsonism and multiple sclerosis)/diseases of the (para)thyroid gland/diseases of the eye, stomach ulcer, other diseases of the digestive system, chronic rheumatic heart disease/hypertensive disease/other forms of heart disease (exc. ischaemic heart disease), cerebrovascular disease, diseases of veins/gangrene, calculi and other diseases of the urinary tract, congenital anomalies, suicide, other external causes of death, other infectious diseases, other diseases
Cluster 8: highly fluctuating, declining trend early 20th century smallpox
Cluster 9: highly fluctuating, declining trend early 20th century cholera and anthrax
Cluster 10: epidemic peaks about every 10 years until 1960 poliomyelitis

Changes in Cause-Specific Mortality in The Netherlands Compared to Other Countries

The differences in time trend of groups of infectious and non-infectious diseases observed in The Netherlands is not unique. Changes in cause-of-death patterns have been reported for many developed as well as developing countries.[1–8,14–16] The decline of certain non-infectious diseases such as stomach cancer and stroke has been reported for many developed countries[17–21] and the increase in the 1920s and 1930s of certain infectious diseases has been described for England and Wales.[22]

In developing countries, CVA was the first cardiovascular disease to emerge as the clinical consequence of high blood pressure, followed by cardiac and renal complications and eventually, angina pectoris and myocardial infarction.[23,24] The Dutch findings showed an early decline of CVA, an increase of heart disease mortality in the first two decades of this century and an ongoing increase of IHD mortality after WW2 whereas other heart diseases started to decline. An early emergence of appendicitis, the increase of cancer of the colon, breast, ovary and prostate, and an increase in smoking-related diseases as well as traffic accidents have also been reported for developing countries.[25–27]

The Results of the Cluster Analysis Compared to Omran's Description of Epidemiologic Transition

The results indicate that an epidemiologic description of mortality decline in terms of a 'decline of infectious diseases' and a 'rise of non-infectious diseases' is far from satisfactory.

As far as the infectious diseases are concerned four groups with a different time trend could be distinguished. The first group (Table 1, cluster 1 and Table 2, cluster 1) might be identified as water- and food-borne infectious diseases or diseases related to poor hygiene and malnutrition. Mortality from those diseases declined progressively in the late 19th and early 20th century.

Typhoid fever, diarrhoea, measles, convulsions, and scurvy belong to this group. The relationship between convulsions and diarrhoea and between measles and diarrhoea has been reported previously.[28,29] The construction of water supply systems, which began in the late 19th century, might have contributed to this decline.[30]

Whooping cough, diphtheria, tuberculosis etc. (Table 2, cluster 2) have also been declining since at least the turn of the century, though less noticeably. This group might be labelled as airborne infections. An important determinant of the decline in this cluster might have been the improvement in nutritional status. This cluster includes several types of tuberculosis, which is a condition that is sensitive to nutritional status.[31] Overcrowding in houses and factories has probably also been a determinant of the diseases in this cluster. In the late 19th and early 20th century several measures were taken by the national authorities to improve housing and working conditions which might have contributed to the decline in the first half of the 20th century.[32]

The third group of infectious diseases (Table 2, cluster 3) declined slowly at the beginning of this century. The decline accelerated after WW2 and this was probably partly due to the introduction of antibiotics at this time.[33]

The last group of infectious diseases, i.e. appendicitis, otitis media/mastoiditis, venereal infections (except syphilis) (Table 2, cluster 4) might be identified as temporarily increasing infectious diseases. A possible explanation is Barker's 'hygiene hypothesis'. Around 1920, improvements in hygiene had reduced enteric infections in young children which made them prone to appendicitis and some other infectious diseases e.g. poliomyelitis in adolescence. As hygiene improved further the likelihood of contracting an infection as a young adult also decreased.[22,34–36]

Increased mortality has only occurred for some of the diseases under the heading 'degenerative and man-made diseases' by Omran. Three groups could be distinguished, but it is hard to characterize those groups in terms of common aetiology and/or cause of decline. Some causes showed a rapid decline at the beginning of this century e.g. stomach cancer, chronic obstructive pulmonary disease (COPD), alcoholism and perinatal causes of death (Table 2, cluster 6). Possible reasons for the decline are e.g. reduced salt intake because of the introduction of other food preservation measures (refrigerator) rather than salting in the case of stomach cancer,[37] and improved obstetric care in the case of perinatal mortality.[38]

Another group of causes on average increased slightly at the beginning of the century and declined slowly after WW2 (Table 2, cluster 7). Heart disease other than IHD had been increasing until 1920 and started to decline in 1950. Some of those heart diseases (e.g. chronic rheumatic heart disease) were infectious in origin and could therefore be affected by changes in hygiene, nutrition and antibiotics, which might explain part of the decline.[39,40]

Only one group of non-infectious diseases has increased throughout the 20th century e.g. IHD, several types of cancer, traffic accidents and homicide (Table 2, cluster 5). Determinants of these causes e.g. high cholesterol intake, smoking habits and changes in reproductive and health behaviour[41–43] might be labelled as changes in behaviour which are related to increased affluence.

CONCLUSION

This detailed analysis of the epidemiologic transition in The Netherlands has shown the diversity in 'the decline of infectious diseases' and 'the rise of degenerative and man-made diseases'. The results of this study suggest that the conventional interpretation of the epidemiologic transition, which assumes a uniform decline of infectious diseases and a uniform increase of non-infectious diseases, needs to be modified. A more differentiated interpretation of changes in mortality in terms of cause of death is likely to provide a better starting point for explanatory analyses.

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APPENDIX *Two aggregation levels of causes of death: 27 causes for the period 1875–1992 and 65 causes for the period 1901–1992. ICD-9 codes are given to indicate which causes of death are included in the different groups*

27 causes 1875–1992	65 causes 1901–1992	ICD9-codes
1. Congenital anomalies	1. Congenital anomalies	740–759
2.* Debility. Several types of tuberculosis. Scrofula. Rachitis. Diseases of skin. Abscess. Ulcer. Gangrene. Pyaemia. Haemorrhage. Continuous fever.	2. Erysipelas	035
	3. Anthrax	022
	4. Disseminated tuberculosis and tuberculosis of other organs	015–018, 137
	5. Gout. Vitamin D deficiency. Diseases of the musculoskeletal system and connective tissue	268, 274, 710–739
	6. Diseases of adrenal glands	255
	7. Senility. Dementia	290, 797
	8. Perinatal causes of death	760–779
	9. Septicaemia. Pyaemia	038
	10. Other infectious diseases	003, 020–021, 023–027, 030–031, 037, 039–044, 051–054, 056–057, 060–061, 065–066, 070–075, 077–083, 085–088, 100–104, 110–118, 120–136, 139, 681–682
	11. Other diseases	201, 204–208, 210–217, 222–239, 251, 253–254, 256–266, 269–273, 275–289, 292–302, 306–319, 471, 680, 683–686, 690–698, 700–709
3. Cancer	12. Malignant neoplasm of oesophagus, stomach, liver and gallbladder	150, 151, 155–156
	13. Malignant neoplasm of small intestines, large intestines, rectum and peritoneum	152–154, 158
	14. Malignant neoplasm of skin	172–173
	15. Malignant neoplasm of breast	174–175
	16. Malignant neoplasm of other organs (including lung)	142, 157, 159–165, 170–171, 179–185, 200, 202–203
4. Scurvy	17. Scurvy	267
5. Typhoid fever	18. Typhoid fever	002
6. Malaria	19. Malaria	084
7. Smallpox	20. Smallpox	050
8. Scarlet fever	21. Scarlet fever	034
9. Measles	22. Measles	055
10. Cerebrovascular disease	23. Cerebrovascular disease	430–438
11. Diseases of the nervous system	24. Tuberculosis of meninges and central nervous system	013
	25. Syphilis	090–097
	26. Hereditary and familial diseases of nervous system. Other diseases of central nervous system. Diseases of nerves and peripheral ganglia. Diseases of (para)thyroid gland. Diseases of the eye	076, 240–246, 252, 330–337, 340–379
	27. Alcoholic psychosis. Alcoholism	291, 303
	28. Encephalitis/meningitis	036, 046–049, 062–064, 320–326
	29. Convulsions	–
	30. Poliomyelitis	045, 138
	31. Diseases of the ear (inc. otitis media)	380–389
12. Respiratory tuberculosis	32. Respiratory tuberculosis	010–012
13. Diabetes mellitus	33. Diabetes mellitus	250
14. Diphtheria. Croup	34. Diphtheria. Croup	032
15. Whooping cough	35. Whooping cough	033

APPENDIX *Continued*

27 causes 1875–1992	65 causes 1901–1992	ICD9-codes
16. Acute respiratory diseases	36. Acute bronchitis. Influenza	466, 487
	37. Pneumonia	480–486
	38. Empyema. Pleurisy	510–511
17. Chronic respiratory diseases	39. Diseases of larynx, pharynx, nasal cavity, oral cavity	460–465, 470, 472–476, 478, 520–529
	40. Chronic bronchitis. Emphysema. Asthma. Other diseases of the respiratory system	415, 477, 490–496, 500–508, 512–519
18. Diseases of circulatory system (exc. cerebrovascular disease)	41. Rheumatic fever. Chorea	390–392
	42. Chronic rheumatic heart disease. Hypertensive disease. Other forms of heart disease (exc. ischaemic heart disease)	393–398, 401–405, 416–417, 420–429, 458–459
	43. Diseases of veins. Gangrene	445, 451–456
	44. Ischaemic heart disease	410–414
19. Dysentery. Acute diseases of digestive system. Diarrhoeal diseases	45. Diarrhoeal disease, dysentery, enteritis	004, 006–009, 532, 555–558, 562
	46. Peritonitis	567
	47. Appendicitis	540–543
20. Cholera	48. Cholera	001
21. Chronic diseases of digestive system	49. Tuberculosis of intestines, peritoneum and mesenteric glands	014
	50. Stomach ulcer	531, 533–534
	51. Other diseases of digestive system	535–537, 550–553, 560, 564–566, 568–569, 570–579
	52. Diseases of oesophagus	530
22. Diseases of the genito-urinary system	53. Venereal infections (exc. syphilis)	098–099
	54. Acute nephritis	580
	55. Chronic nephritis. Other diseases of kidney	581–591, 593
	56. Calculi of urinary tract and other diseases of urinary tract	592, 594–599
	57. Diseases of prostate. Other diseases of male genital organs	600–608
	58. Diseases of female genital organs	218–221, 610–611, 614–629
23. Puerperal diseases (exc. puerperal fever)	59. Complications of pregnancy, childbirth and the puerperium (exc. puerperal fever)	630–639, 640–648, 650–669, 671–676
24. Puerperal fever	60. Puerperal fever	670
25. External causes of death (exc. suicide)	61. Homicide	E960–969
	62. Traffic accidents	E800–807, E810–829
	63. Other external causes of death	005, 304–305, E830–838, E840–848, E850–876, E878–888, E890–903, E905–949, E970–978, E980–999
26. Suicide	64. Suicide	E950–959
27. Unspecified, ill-defined or unknown causes of death. Sudden death	65. Unknown and ill-defined causes of death. Sudden death	780–796, 798–799, E904

[a] This category consists of several causes of death which cannot be put under one heading. Debility is a 19th century cause of death mainly consisting of senility and perinatal causes of death. Only types of tuberculosis other than mentioned elsewhere in this Table are included. Haemorrhage related to pregancy or respiratory tuberculosis is not included in this category.