ORIGINAL RESEARCH ARTICLE

Measuring health in inmates using a synthetic index: A study of a 41 bis prison in central Italy

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ABSTRACT

Background: Global prison population has increased worldwide approximately 24% since the 2000s. The objective of our study was to create a health status index for inmates at the L'Aquila prison and to describe their health profiles.

Methods: The pathologies examined concerned: heart valves, arterial ischemia, cerebral vascular accidents, endocrine diseases, Type 2 diabetes, malignant and benign neoplasms. In addition, respiratory, kidney, urogenital, osteo-articular, gastrointestinal, neurological, anemia, otorhinolaryngology, ophthalmology, dermatological, dental, and infectious diseases. A score was given to the therapies: 0-absence of therapy; 1-monotherapies; 2-polytherapies; 3-high-cost therapies. The health state was: good, fairly good, poor, compromised/serious. The pathologies taken into consideration were introduced into the MCA model to highlight health profiles.

Results: The synthetic health index showed the following health status: good (25 cases, 15.9%), fairly good (104, 66.2%), poor (25, 15.9%), compromised/serious (3, 1.9%). The MCA identified three profiles. The first consisted of individuals aged ≥60, with the presence of arterial hypertension, respiratory diseases, cardiovascular diseases, endocrine diseases, neoplasms, and compromised/serious health status. The second were inmates aged 50 to 59, with renal, gastrointestinal, neurological and infectious diseases, undergoing psychological treatment, with an average health status index. The third consisted of individuals under 50 with no underlying health conditions.

Discussion: prevention must be a priority among young people in good health, to prevent their well-being from declining to a fair level, and above all, to prevent further deterioration into mediocre conditions. In conclusion, early

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intervention with preventive measures allows young prisoners to maintain optimal health, reducing the risk of developing chronic diseases or complications over time.

Key words: italian prison, 41bis, inmates, noncommunicable diseases, synthetic index

Introduction

The prison environment represents a unique and complex challenge to manage. The importance of health policies and targeted interventions to improve the health of inmates is not only ethical, but also a public health problem. Indeed, a large proportion of them will likely return to poor health conditions if not treated appropriately. Healthcare in prison varies widely among countries and differences in offered services affect morbidity, mortality (1) and healthcare costs (2). The prison population does not benefit from the same health status as the free population (3-5). Living conditions in prison, due to socio-economic and health determinants, such as forced cohabitation in restricted spaces, loss of privacy and personal freedom, overcrowding and poor hygienic-sanitary conditions, make a specific and targeted approach to health management within Penitentiary Institutions indispensable (6). These determinants could have negative effects on the mental and physical health of prisoners, exacerbating pre-existing problems and promoting comorbidity (7). Numerous studies highlight how prisoners are characterized by a higher prevalence of communicable and chronic diseases such as diabetes, hypertension, cardiovascular diseases (5,8). A significant contribution to non-communicable diseases is related to sedentary lifestyle, stress related to the deprivation of freedom, and an inadequate diet (9,10). Regarding the latter, it is known that it is rich in fats and sugars, often accompanied by the consumption of alcohol (11). It is well known that a healthy diet is a key component to maintaining a healthy lifestyle and preventing the increase of noncommunicable diseases (12). In addition, it is known that inmates have sleep disorders (13). Sleep disturbances appear to be associated with an increased risk of non-communicable diseases (14). It should be noted that chronic respiratory diseases, such as asthma and chronic obstructive pulmonary disease (COPD), are worsened by the presence of a very high percentage of heavy smokers (15). Osteo-articular diseases also represent a major health problem as many prisoners suffer from chronic pain and joint disorders due to uncomfortable living conditions and the lack of regular physical activity (16). Promoting disease prevention and treatment programs is therefore crucial. These programs should include awareness and health education campaigns, regular screenings for early diagnosis of diseases, vaccinations, and access to appropriate treatment. Indeed, the World Health Organization (17) recommends that all individuals are screened initially and then regularly throughout their time in prison to assess their mental and physical health. Some of these specific recommendations are within the first week of custody. All individuals should undergo a thorough health assessment to identify all physical and mental health needs. Subjects requiring treatment should be referred to the appropriate health services. Furthermore, Member States should implement validated screening tools that capture information on noncommunicable diseases, including cardiovascular disease, respiratory disease, diabetes and cancer, as well as their associated risk factors – tobacco smoking, harmful alcohol use, nutrition and physical activity. It should be emphasized that providing coordinated health care in prison improves individuals' health after release, resulting in long-term savings. A study conducted by Binswanger et al (18) highlighted that coordinating efforts between the prison system and the community is essential. In fact, the provision of preventive care in prison provides a benefit that affects the community after release. The objectives of our study were: (i) to create a health status index for inmates held at the L'Aquila prison; (ii)

to describe the inmates' profiles using multiple correspondence analysis.

Materials and methods

L'Aquila houses prisoners according to the law of 10 October 1986, n. 663, art. 41 bis, which identifies the so-called "hard prison" in Italy. It is a form of restrictive detention intended for individuals who commit offenses related to organized crime. The 41 bis has 2 main characteristics: the limitation of the outdoor activity of the detainees to a maximum of 2 h and a maximum number of 3 inmates with whom an inmate can socialize. The 41 bis is applied for very long periods, even 20/30 years, a real form of isolation. Data of male inmates in the maximum-security prison of L'Aquila as of July 31, 2023, extracted from an electronic database in anonymous form. Female inmates were not included in the study because they were small in number (12 units aged between 42 and 76 years of age). The following main pathology groups were considered for each inmate: valvular heart diseases, ischemic arterial disease, cerebral vascular accidents, endocrine metabolic diseases, Type 2 diabetes, respiratory diseases, malignant neoplasms, benign neoplasms, kidney and urogenital diseases, osteo-articular diseases or consequences of trauma, gastrointestinal, neurological, anemia or other diseases affecting the hematopoietic system, otorhinolaryngology and ophthalmology pathologies, dermatological, dental, and infectious diseases (Table S1).

According to the pharmacological therapies administered by doctors for each disease or health condition taken into consideration, a score was attributed: 0-absence of therapy (no pharmacological treatment prescribed); 1-monotherapies (pharmacological treatment with a single drug prescribed for a specific disease); 2-Polytherapies (polytherapeutic treatment prescribed, either for a single disease or for multiple diseases); 3-High-cost therapies (polytherapy); 4-High healthcare cost (it includes both pharmacological treatment and global healthcare assistance, as well as medical visits, specialist consultations, diagnostic tests, blood tests, prescription of medical devices, etc, in subjects with two or more pathologies). In particular, high-cost therapies: presence of multiple pathologies (>=2) requiring multiple therapies. To protect the subject's identity, the single subject with a pathology score of 4 was grouped into the category with a score of 3. Subsequently, using the health status classification previously described, a synthetic health index was constructed for each prisoner according to the methodology described in: http://www.ristretti.it/areestudio/cultura/libri/divenire_medicina_penitenziaria.pdf (accessed on 16 November 2023) (Figure S1). Multiple correspondence analysis (MCA) was used to construct health profiles. To this end, some of the collected variables were merged, making them dichotomous (0-absence of pathology/condition; 1-presence). Furthermore, the age group (30-49, 50-59, 60-69 and ≥70) was also included in the analysis. The variables considered in the MCA were (Table 1): C (hypertension), F (respiratory diseases), G (malignant neoplasms), H (benign neoplasms), I (kidney and urogenital), J (osteo-articular or consequences of trauma), K (gastrointestinal), L (neurological), M (anemia or other diseases affecting the hematopoietic system), P (psychiatric disorders), R (Infections: urinary tract, HBV, HCV, HIV), S (health status index) and age group. In addition, 3 new variables were constructed: A+B (valvular and ischemic heart), D+E (endocrine metabolic and type 2 diabetes) and N+O+Q (Otorhinolaryngology and ophthalmology pathologies, dermatological and dental diseases). All the variables related to the conditions/pathologies were classified into dichotomous variables (1-presence and 0-absence), and the health status index was transformed in order to have only three values (0, 1, 2, including in the value 2 all cases with value ≥2). Age was divided into four groups: 30-49 (49 subjects, 31.2%), 50-59 (51, 32.5%), 60-69 (48, 30.6%) e ≥70 (9, 5.7%). The health state was classified as follows. *Good*: no chronic or acute illnesses and no medication being taken; *fairly good*: presence of one or more mild conditions, under medication and well-compensated; *poor*: fair health but not yet compromised; presence of moderate conditions under medication, still compensated; *compromised/serious*: deterioration of physical and mental well-being; presence of chronic conditions under medication, no longer compensated and progressively evolving; presence of a serious condition (cancer)

requiring medication and a high level of care. Loss of patient autonomy. The Kruskal Wallis test was applied to estimate the differences in mean age between health status groups. The statistical analyses and graphical representations were performed using the Excel and R software, ver. 4.3.3, with the libraries: FactoMineR, ggplot2, factoextra, ggpubr and ggforce. The procedure for this research project conforms to the provisions of the Declaration of Helsinki. The authorization to process the data was obtained on 3 August 2021 (protocol number 0169071/21). Furthermore, the study protocol was approved by the Internal Review Board of the University of L'Aquila.

Results

As of 31/07/2023, there were 157 male inmates at the maximum-security prison in L'Aquila (Italy). The mean age was 53.17 years, with a standard deviation of 12.42 and a range (20; 83).

The frequency distribution of each pathology/condition and its therapy are reported in Table 1.

Table 2 shows the distribution of the synthetic health index and the mean age (+sd): good (25 cases, 15.9%), fairly good (104, 66.2%), poor (25, 15.9%), compromised/serious (3, 1.9%), with $p = 3.4 \times 10^{-6}$.

Ophthalmological, ENT, dermatological, and dental conditions were grouped into a single variable because they referred to services not related to chronic conditions and were coded with the acronym NOQ (Table 3).

The Multiple Correspondence Analysis (MCA) revealed three distinct profiles (Figure 1).

- **Profile 1:** Individuals aged 60 and older, characterized by a serious health status and the presence of chronic conditions such as arterial

Table 1. Distribution of diseases according to therapy

Disease groups	No therapy (score=0) No. of cases (%)	Mono-therapy (score=1) No. of cases (%)	Poli-therapy (score=2) No. of cases (%)	High costs of therapy (score=3 and 4) No. of cases (%)
A -Valvular heart	149 (94.9)	2 (1.3)	6 (3.8)	0 (0.0)
B - Ischemic heart	149 (94.9)	0 (0.0)	8 (5.1)	0 (0.0)
C - Hypertension	124 (79.9)	31 (19.7)	2 (1.3)	0 (0.0)
D - Endocrine	92 (58.6)	48 (30.6)	17 (10.8)	0 (0.0)
E - Type 2 diabetes	150 (95.5)	1 (0.6)	6 (3.8)	0 (0.0)
F - Respiratory	147 (93.6)	1 (0.6)	7 (4.5)	2 (1.3)
G - Malignant neoplasms	149 (94.9)	1 (0.6)	6 (3.8)	0 (0.0)
H - Benign neoplasms	148 (94.3)	4 (2.5)	5 (3.2)	0 (0.0)
I – Kidney/urogenital	119 (75.8)	32 (20.4)	6 (3.8)	0 (0.0)
J - Osteoarticular/trauma	104 (66.2)	12 (7.6)	36 (22.9)	5 (3.2)
K - Gastrointestinal	115 (73.2)	30 (19.1)	12 (7.6)	0 (0.0)
L - Neurological	137 (87.3)	3 (1.9)	16 (10.2)	1 (0.6)
M – Anemia or other hematopoietic diseases	147 (93.6)	7 (4.5)	3 (1.9)	0 (0.0)
N- Otorhinolaryngology/ophthalmology	117 (74.5)	24 (15.3)	14 (8.9)	2 (1.3)
O – Dermatological	146 (93.0)	0 (0.0)	11 (7.0)	0 (0.0)
P - Psychiatric disorders	120 (76.4)	18 (11.5)	18 (11.5)	1 (0.6)
Q – Dental	145 (92.4)	2 (1.3)	5 (3.2)	5 (3.2)
R - Infections (urinary tract, HBV, HCV, HIV)	150 (95.5)	0 (0.0)	7 (4.5)	0 (0.0)

Table 2. Distribution of inmates' health status according to index

Health status index	Number of cases (%)	Mean age (year)	Standard deviation
Good	25 (15.9)	40.32	14.21
Fairly good	104 (66.2)	54.44	10.87
Poor	25 (15.9)	59.96	7.83
Compromised/serious	3 (1.9)	59.33	2.89
Kruskal-Wallis test	$p=3.4\times10^{-6}$		

Table 3. Results of multiple correspondence analysis according to variables used

	Variable value	
Variable	**0**	**1**
AB (*Valvular heart + Ischemic heart*)	139 (88.5)	18 (11.5)
C (*Hypertension*)	124 (79)	33 (21.0)
DE (*Endocrine + Type 2 diabetes*)	91 (58.0)	66 (42.0)
F (*Respiratory*)	147 (93.6)	10 (6.4)
G (*Malignant neoplasms*)	149 (94.9)	8 (5.1)
I (*Kidney/urogenital*)	119 /75.8)	38 (24.2)
J (*Osteoarticular/trauma*)	104 (66.2)	53 (33.8)
K (*Gastrointestinal*)	115 (73.2)	42 (26.8)
L (*Neurological*)	137 (87.3)	20 (12.7)
NOQ (*Otorhinolaryngology/ophhal-mology + Dermatological + Dental*)	100 (63.7)	57 (36.3)
P (*Psychiatric disorders*)	120 (76.4)	37 (23.6)
R (*Infections: urinary tract, HBV, HCV, HIV*)	150 (95.5)	7 (4.5)
S (*health status index*)	25 (15.9)	104 (66.3)

hypertension, respiratory, cardiovascular, endocrine, and neoplastic diseases.

- **Profile 2:** Inmates aged 50 to 59, exhibiting an average health status index. This group was associated with renal, gastrointestinal, neurological, and infectious diseases, and was undergoing psychological treatment.
- **Profile 3:** Individuals under 50, distinguished by the absence of underlying health conditions.

Discussion

The prison population has increased rapidly in recent years. Prisoners are a vulnerable group who, compared with the general population, experience poorer health outcomes (19). Healthcare in prison varies widely among countries, and differences in services provided affect morbidity, mortality, inside custody (1). Upon release (20), it affects healthcare costs. In general, high healthcare costs are attributed to the diagnosis, treatment, and therapy of malignant tumors. Managing health in prison requires an integrated approach that takes into account the unique characteristics and specificities of this context. It is essential to ensure inmates have access to adequate and timely medical care. This includes not only primary healthcare but also specialized care to address the complex needs of the prison population, often characterized by a high incidence of chronic and infectious diseases (5,7). Furthermore, improving the hygiene and infrastructure conditions of prison facilities is crucial (21). This involves targeted interventions to reduce overcrowding,

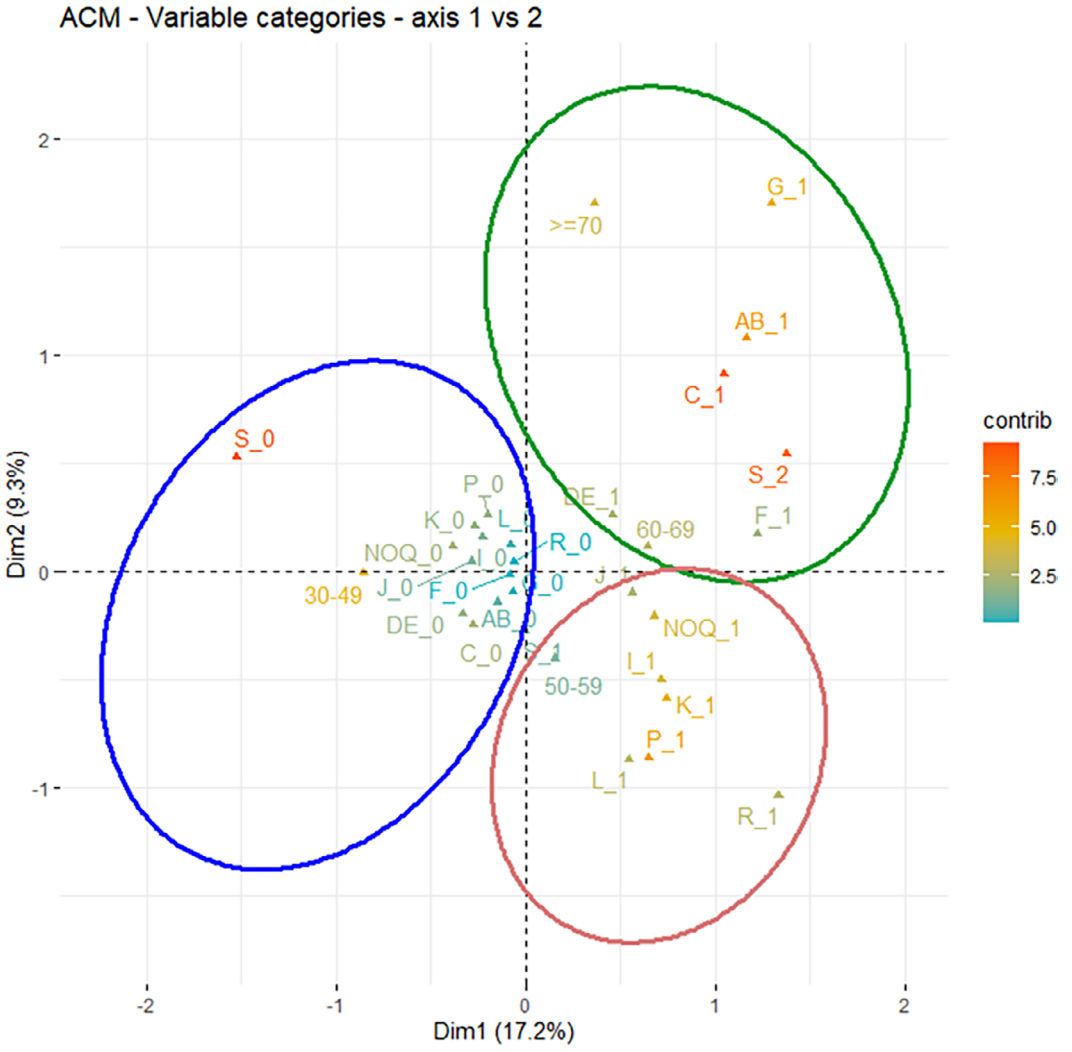

Figure 1. MCA. Profiles. Dim1: dimension 1; Dim2: dimension 2. Contrib: contribution.

ensure cleanliness, provide access to adequate sanitation, and promote healthy eating. Improved living conditions can significantly contribute to preventing the spread of disease and improving the overall well-being of inmates. Only through a coordinated and continuous commitment is it possible to improve the health status of prisoners, thus contributing to the protection of public health in a broader sense (16,22,23). The L'Aquila prison's inmate population, specifically those under the 41 bis regime, was the focus of this research. By collecting and analyzing detailed health data, a thorough understanding of the inmates' health status was achieved. This comprehensive assessment serves to identify areas where preventive and therapeutic healthcare interventions are most needed. Analysis of the subjects detained in L'Aquila prison, as shown in Table 2, reveals an average age of approximately 54 and a predominantly fair state of health. Conversely, only a minor proportion of the population presents with a mediocre health status, which tends to decline further with increasing age. It will be essential to try to maintain this condition to prevent a worsening of their condition. We subsequently identified, through multiple correspondence analyses, inmate profile characteristics. The first is a person over 60 years of age with cardiovascular disease, high blood pressure, and

urogenital diseases, thus requiring increased prevention and pharmacological therapy. The second case involves an older prisoner, aged 50–59, presenting with multiple co-existing conditions, including renal, gastrointestinal, neurological, and infectious diseases, along with dermatological, ophthalmic, ENT, and dental issues. Conversely, the third case describes a younger prisoner, under 50, who has no underlying medical conditions. Prevention must be a priority among young people in good health, to prevent their well-being from declining to a fair level, and above all, to prevent further deterioration. Early intervention with preventive measures allows young prisoners to maintain optimal health, reducing the risk of developing chronic diseases or complications over time. Improving the health of inmates through targeted policies and interventions is crucial, not only for ethical reasons but also for public health. This is because a significant number of inmates are likely to be released in poor health if they do not receive appropriate treatment while incarcerated.

Limits

Our study has two main limitations. First, the summary index used for the Multiple Correspondence Analysis (MCA) was derived from a non-peer-reviewed source, which should be addressed in future research. Second, by focusing solely on prisoners under the 41bis regime, we were unable to compare our findings with those of the general prison population, suggesting a direction for further investigation. Nonetheless, our work offers valuable suggestions for subsequent studies.

Conclusions

Preventive measures are crucial for both the personal health of inmates and the efficiency of the entire prison healthcare system (22, 24). A healthy prison population helps to lower overall costs by decreasing the need for more complex and intensive medical interventions that arise from worsening health. Furthermore, promoting health within prisons represents a long-term investment that yields broader societal benefits. By improving the physical and mental health of incarcerated individuals, this approach contributes to reduced recidivism and smoother social reintegration.

Abbreviations:

The following abbreviations are used in this manuscript:

A	Valvular heart
B	Ischemic heart
C	Hypertension
D	Endocrine metabolic
E	Type 2 diabetes
F	Respiratory diseases
G	Malignant neoplasms
H	Benign neoplasms
I	Kidney and urogenital
J	Osteo-articular or consequences of trauma
K	Gastrointestinal
L	Neurological
M	Anemia or other diseases affecting the hematopoietic system
N	Otorhinolaryngology and ophthalmology pathologies
O	Dermatological
P	Psychiatric disorders
Q	Dental
R	Infectious Diseases/HIV
S	Health status index
AB	A and B co-presence
DE	D and E co-presence
NOQ	N, O and Q co-presence

Ethic Approval: The authorization to process the data was obtained on 3 August 2021 (protocol number 0169071/21).

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

Author's Contribution: "Conceptualization, E.A..; methodology, E.A. and C. M.; software, C.M.; validation, E.A, F.G. and R.P.;

formal analysis, C.M. and E.A..; investigation, F.G..; data curation, F.C. and C.M.; writing—original draft preparation, I.P., E.A. R.P.; writing—review and editing, E.A. and C.M..; supervision, E.A.;. All authors have read and agreed to the published version of the manuscript."

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ANNEX

Table S1. Main pathologies detected

Gastrointestinal system:	**Respiratory system:**	alopecia
chronic gastritis	chronic obstructive bronchitis	onychodystrophy
hepatic steatosis	pulmonary fibrosis	plantar hyperhidrosis
alcohol-related liver cirrhosis	bronchial asthma	**Periodontal diseases**
chronic HCV/HIV hepatitis	tbc	**Otorhinolaryngology/ophthalmology diseases:**
dyslipidemia	**Osteoarticular and rheumatic diseases:**	hearing loss
colonic diverticulosis	low back pain	cataracts
gallstones	general osteoarthritis	chorioretinopathy
Gilbert syndrome	radiculopathy	diplopia
hiatal hernia	inguinal hernia	**Neurological diseases:**
anal fissures	discopathy	epilepsy
chronic constipation	gonarthrosis	headache
Endocrine-metabolic system:	rheumatoid arthritis	migraine
type 2 diabetes	spondyloarthritis	anxiety
obesity	fibromyalgia	depression
Graves' disease	Sjogren syndrome	stroke
autoimmune hypothyroidism	scoliosis	**Hematological diseases:**
postsurgical hypothyroidism	coxarthrosis	monoclonal gammopathy
hyperuricemia	lumbosciatica	anemia
hyperparathyroidism	**Benign and malignant neoplastic diseases:**	beta-thalassemia minor
thyrotoxicosis	papillary microcarcinoma	**Kidney/urogenital diseases:**
Cardiovascular system:	squamous cell papilloma	ipertrofia prostatica benigna
arterial hypertension	prostate cancer	riduzione contrattilità vescica
acute myocardial infarction	thyroid nodules	ostruzione cervico-uretrale
ischemic heart disease	pulmonary micronodules	**Infectious diseases:**
ascending thoracic aortic ectasia	melanoma in situ	urinary tract infections
carotid atheromatous plaques	pituitary microadenoma	HBV
mild aortic or mitral regurgitation	osteomeningioma	HCV
pulmonary hypertension	**Dermatological disease:**	HIV
venous insufficiency of the lower limbs	psoriasis	
atrial fibrillation	allergy disorders	
aortic ectasia	vitiligo	

Procedure:
Let be Index = health status index,
Let be Xi i-th disease with i from: 1,2,3, to 20
Ni is the value that each disease can take on; these values will be: 0,1,2,3,4, for i=1,…,20
Let be C1 the number of Ni =1
Let be C2 the number of Ni =2
Let be C3 the number of Ni =3
Let be C4 the number of Ni =4
Index=4 (serious health status) if
($C4 \geq 1$ and $C3 \geq 1$) or ($C4=1$ and $C2 \geq 2$) or ($C3 \geq 3$ and $C2>2$) or $C4>1$
Index=3 (compromise health status) if
$C4=1$ or ($C3>1$ and $C2>2$) or ($C3=1$ and $C2>3$) or $C3>3$
Index=2 (poor health status) if
$C3 \geq 1$ or $C2 \geq 4$ or ($C2>1$ and $C1>3$) or ($C2>0$ and $C1>4$) or $C1 \geq 6$
Index=1 (Fairly good health status) if
$C2>0$ or $C1>0$
Index=0 (good health status) if
$C1=C2=C3=C4=0$

Figure S1. Estimation of health status index.