EPIZOO: software for veterinary epidemiology training and problem-solving

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Described is a computer software package, EPIZOO, which has been developed specifically for under-graduate and postgraduate education, self-training, problem-solving, and simulation studies in veterinary epidemiology. The program is based on action-oriented animal population health/disease analyses and programming. EPIZOO runs on IBM-compatible personal computers and can be used for any animal population diseases, including those transmissible to man. The software comprises an integral system of selected indicators contained in twelve modules, with about 200 widely applicable methods used in epizootiology. It is user-friendly and includes general methods related to the following: animal population characteristics of health/disease importance; analysis of animal population health and disease situations, structures, dynamics, diagnoses, and consequences; preparation, cost, and evaluation of animal population health programmes; and selected statistical techniques.

Introduction

Veterinary epidemiology (epizootiology), which deals with animal population health and disease processes, analyses, and respective actions, uses different methods that have to be applicable under a great variety of conditions. Processing and analysing large amounts of data are demanding, but one way to facilitate this work is by the use of computers. The time thus saved can be used by veterinarians to carry out, for example, field investigations and disease control measures.

The following computer programs for human epidemiology, produced by or in cooperation with WHO, are also suitable for veterinary epidemiological purposes: EPI-INFO5, EPIMAP, EPIMODEL, EPISTAT, and EPICOST. Examples of specific veterinary epidemiology software are EPISCOPE, CHAPTERS, EXOTICA, and PANACEA. Several other veterinary computer programs are available but these deal usually only with particular aspects of veterinary epidemiology, without aiming at follow-up actions.

There is a need for a more complex software package that reflects the enormous diversity of veterinary epidemiological problems and their solution, and this was the reason for developing the EPIZOO software package, which is described in this article.

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Materials and methods

The main criteria used in developing EPIZOO were as follows:
— it should be a wide-ranging computer program for undergraduate and postgraduate education, self-training, and problem-solving for decision-making purposes;
— it should employ only methods that have already proved useful and practical in animal population health/disease analyses and in successful programmes of disease prevention, control, and eradication;
— it should be applicable to any animal species for general health and morbidity purposes, for any specific health and disease, including those transmissible to man, and for infectious as well as noninfectious diseases;
— the methods selected should be general so that they can be applicable anywhere and at any time;
— it should be user-friendly and easy to operate (even by computer novices);
— it should provide feedback to the user in case of input errors and permit their correction;
— the input should be based on answering the questions and the output should be obtained immediately in the form of text, tables, and graphs;
— it should be easy to print the input data and the results directly from the screen;
— it should take up only one 1.4-Mbyte diskette without requiring compression;
— it should be possible to operate also directly from the diskette drive, i.e., it should not require installation on the hard disk.

These relatively demanding criteria preclude a large program, limit the size of subprogram data inputs, and rule out a methodological description (references are made to a bibliographical list at the beginning of the program). Therefore, for processing large amounts of data or of data that require the use of more sophisticated methods, storage, or spreadsheets, alternative software packages should be employed.

The program is written in Turbo Basic (Borland International, Inc.) and the graphs are based on ASCII symbols. EPIZOO can be run directly from either the diskette drive or the hard disk of IBM-compatible personal computers that use the MS-DOS operating system (version 4 or higher).

EPIZOO is simple to use. After keying in "EPI-ZOO" and scrolling past initial information, instruction notes, and a bibliographical list, the user has access from the main menu and various submenus to various subprograms. The program automatically poses questions about the data to be processed and the various options presented are chosen by the user. Results in the form of text, tables, and graphs are obtained immediately. The screen contents can be printed using the "Print screen" key.

EPIZOO version 2.5 (April 1994) is written in English and consists of 12 modules, each comprising several subprograms, many of which are subdivided into more specific applications. It covers all major aspects of animal population health analysis and programmes and includes about 200 simple methods for training, problem-solving, and simulation.

The selection of topics and methods is based mainly on the author's experience in investigating, controlling, and eradicating animal diseases (including zoonoses) at local, national, and international levels, as well as in undergraduate and postgraduate teaching. Material produced by international organizations as well as standard textbooks were used to identify important areas of veterinary epidemiology that should be incorporated (14–16).[a]

Almost all the methods used in EPIZOO have been described previously (6). The sampling methods employed are described by Jenicek & Cleroux (5) and the statistical methods by Spiegel (10) and Putt et al. (9). Some of the specific methods used have been described by Astudillo et al. (1), Cannon & Roe (3), Kubankova & Hendl (7), and Martin et al. (8). Also, some of the subprograms have been compared with and/or tested using methods and examples reported by Bögel et al. (2), Frankena et al.

(4), Stöhr,[b] Tacher et al. (11), Thrusfield (12), and Yamane Taro (13).

The software package has been tested in various local, national, and international disease control programmes (brucellosis, tuberculosis, etc.), as well as in several undergraduate and postgraduate courses, both national and international.

Structure of EPIZOO software

First module: selected animal population characteristics of health importance. This covers the following: methods for analysing animal population numbers, species, categories and structures, as well as their distribution in relation to territory and economic and ecological conditions; selected indicators related to disease-resistant and susceptible animals; methods for analysing animal population vertical dynamics (population growth, replacement–restocking, addition/withdrawal rates, survival rates, generation and production cycles, etc.); methods for analysing average production per animal, input, unit space and time; and methods for analysing the average numbers of animals and livestock units per space unit, inhabitant, and veterinarian.

Second module: basic indicators system for animal population health analysis. This covers the following: general indicators, indicators of presence/absence of animal population health phenomena, including disease persistence, selected indicators of animal population health, morbidity (prevalence, incidence and extinction rates, attack rates, specific disease proportional rates, etc.), viability (survival rates, fertility, and natality rates, etc.) and mortality (general crude, specific, neonatal, lethality, etc.); indicators of animal population disease nidality (focality) and territorial indicators; methods for estimating animal population disease prevalence from simple and cluster samples; and basic indicators for demographic analysis, animal/human population ratios, and the ratios of animals/humans affected by zoonoses.

Third module: methods for the adjustment (standardization) of animal population health rates. This contains the following: adjustment of population health rates based on category structure standards; morbidity/mortality adjustment based on category rates standards; and two-population rates adjustment based on standard proportions and on category standards.

Fourth module: animal population health structures and risk analysis. This contains selected methods for analysing the following: animal population epizootiological structures and disease space structures (territorial distribution and density); structure of animal disease foci and territories; morbidity, mortality, focality, ·and territorial structure according to different causes/forms; disease occurrence according to animal species and categories, as well as economic and ecological conditions; animal disease risk; risk probability assessment of disease introduction and propagation; and per capita consumption of food of animal origin (as potential zoonoses risk for human populations).

Fifth module: epizootic process dynamics. This contains selected methods for analysing the following: current and chain comparative indices of animal population health dynamics; average of changing numbers of diseased animals, foci, etc.; seasonal trends in animal population health/disease phenomena; tendency of animal morbidity and disease nidality; relations between new cases and space, time, diseased animals, and foci; population vertical movements and chronic disease processes; number of diseased animals according to survival rates; territorial propagation of transmissible diseases; development of diseases with cyclical, ascending, and descending tendencies; and chronological time series of animal health phenomena.

Sixth module: positive and negative consequences of animal population health/disease. This contains methods for analysing the following: animal health benefits and disease losses in production; public health consequences of zoonoses; specific disease losses, according to average parameters; losses due to death and condemnation of diseased animals; losses due to reduction in use of specific animal populations; losses due to reproductive deterioration of specific animal populations; benefit/losses of inputs in healthy/diseased animals; cost of mass health actions in animal populations; and economic losses due to animal population diseases and costs of countermeasures.

These subprograms are appended by summary tables of losses due to animal population diseases.

Seventh module: investigations of the health of animal populations. This contains analytical methods for the following: evaluation of diagnostic method quality and of animal population investigation grade; proportions of different types of diagnostic tests; infectious disease evidence and notification grades; positivity and negativity of test results; agreement between the test results of two investigators; and concordance grade of compared test results and population/sample multi-etiological investigations.

This group of subprograms is appended by summary tables of numbers and results of investigations, according to disease, species/categories, territory, time series, and test types.

Eighth module: sampling methods used in animal population health investigations. This contains methods for the following: generation of random numbers for selecting representative animals and for cluster as well as multistage sampling; calculation of the minimum sample size for detecting the presence of a disease in a population; estimating the prevalence of a disease in a large population; estimating prevalences using confidence intervals and absolute differences; estimating prevalences in finite populations; detecting significant differences between two prevalences; and estimating means of health phenomena and detecting significant differences between two means.

This set of subprograms ends by including stratified sampling methodology.

Ninth module: selected aspects of animal population health programmes. This contains methods for the following: selection of priority diseases for animal population health strategies (based on disease importance, solution feasibility and availability of inputs); simple model for changes in animal morbidity prognosis; planning reductions in the number of diseased animals (in linear and curve forms); planning specific health recovery in animal populations; planning expansions in disease-free territories, zones, and herds; planning a reduction in nidality, mortality, and losses due to diseases; analysing specific animal health mass actions (including vaccinations and mass treatment), according to species, area, time series and types; application of the "critical path" procedure to the planning of animal population health; planning adequate distribution of animal population health programme inputs; and coverage analysis and implementation of animal population health programme measures.

Tenth module: cost and efficiency of animal population health programmes. This contains methods for analysing the following: simple indicators of economic cost–benefit; simple, absolute economic benefits of population health programmes; biological and public health cost-effectiveness of animal population health programmes; critical point of production economic efficiency; efficiency of prophylactic measures and recovery rates; endpoints in populations with and without programmes; consumption and cost of vaccines, drugs, and other substances; and application of interest, discount and inflation rates, and cost–benefit ratios in discounted monetary values.

Conversions between national currencies can be carried out using a complementary subprogram.

Eleventh module: selected statistical methods. This contains methods for calculating the following: arithmetic mean and measures of dispersion; arithmetic mean from grouped data and measures of dispersion; proportions, including standard deviations; conversion between percentages/proportions and absolute data; distribution of cumulative frequencies; χ^2 test and contingency tables; McNemar's test—paired χ^2 test; Fisher's test for comparison of small samples; linear regression and correlation coefficients; chronological time series and moving averages; and smoothing of time series.

Twelfth module: further statistical methods. This contains methods for calculating the following: tests for the difference between two proportions and between two arithmetic means; test for the difference in the means of two small samples; test for matched comparison between pairs of values; estimates of confidence intervals for the population mean and proportions; confidence intervals for the difference between means and between proportions; and differences between real and predicted (model) values and Student's t-test critical values.

Conversion between metric and imperial/U.S. measures can be carried out using a complementary subprogram.

The quality of the results obtained using EPIZOO depends mainly on the following: selecting the most suitable subprogram; the reliability of the input data obtained from field and laboratory investigations; and the use of precise definitions. The interpretation of results must be logical and take into consideration expected follow-up actions.

EPIZOO can be obtained free of charge by sending a 1.4 Mbyte ($3\frac{1}{2}$ inch) diskette to Chief, Veterinary Public Health, Division of Communicable Diseases, World Health Organization, CH 1211 Geneva 27, Switzerland.

Résumé

EPIZOO: un didacticiel pour l'épidémiologie vétérinaire

Cet article décrit un logiciel (EPIZOO) spécialement mis au point pour l'enseignement supérieur et destiné à l'apprentissage, à l'auto-formation, à la résolution de problèmes et aux études de simulation en épidémiologie vétérinaire. Le programme est basé sur des analyses de santé/maladie des populations animales en vue de l'action et sur la programmation de stratégies. EPIZOO peut être utilisé sur un ordinateur personnel IBM-compatible pour n'importe quelle maladie animale, y compris celles transmissibles à l'homme, n'importe quelle espèce animale et n'importe quel effectif de population. Il comprend un système complet d'indicateurs, répartis en douze modules, et expose environ 200 méthodes largement applicables. Il est facile à utiliser et contient des méthodes générales relatives aux caractéristiques de la population animale importantes du point de vue de la santé ou de la maladie, à l'analyse de la situation sanitaire de la population animale, y compris la structure, la dynamique, le diagnostic et les conséquences de la santé/maladie, à la préparation, au coût et à l'évaluation des programmes concernant la santé de la population animale, et à diverses méthodes statistiques.

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13. **Yamane Taro.** *Elementary sampling theory.* New York, New York University Press, 1979.
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Annex

Examples of selected EPIZOO subprograms, showing screen-prompts and outputs

Module 4.6: Disease occurrence structure according to animal species and categories

This subprogram calculates disease occurrence according to

1) species (host range)

2) categories

Enter choice number: 1

Input data:

Disease: ? rabies (according to WHO Rabies Bulletin Europe — 4/92)

Place, time: ? Europe, 1992

Number (up to 11) of species: ? 11

List of data:

Name (up to 15 characters) of the species, number of diseased animals:

1: ? dog, 778

2: ? cat, 622

3: ? cattle, 919

4: ? horse, 52

5: ? sheep/goat, 315

6: ? other dom. anim., 17

7: ? fox, 7 318

8: ? badger, 165

9: ? other musteline, 265

10: ? deer, 251

11: ? other wild anim., 361

Result

**Disease: rabies (according to WHO Rabies Bulletin Europe — 4/92)**

Place: Europe   **Time: 1992**

Species	Diseased animals	Proportion	Percentage
Dog	778	0.070325	7.0325
Cat	622	0.056223	5.6223
Cattle	919	0.083070	8.3070
Horse	52	0.004700	0.4700
Sheep/goat	315	0.028473	2.8473
Other dom. anim.	17	0.001537	0.1537
Fox	7 318	0.661484	66.1484
Badger	165	0.014915	1.4915
Other musteline	265	0.023954	2.3954
Deer	251	0.022688	2.2688
Other wild anim.	361	0.032631	3.2631
Total	11 063	1.000000	100.0000

Species structure of diseased animals

(■ represents 2% of total 11 063 diseased animals)
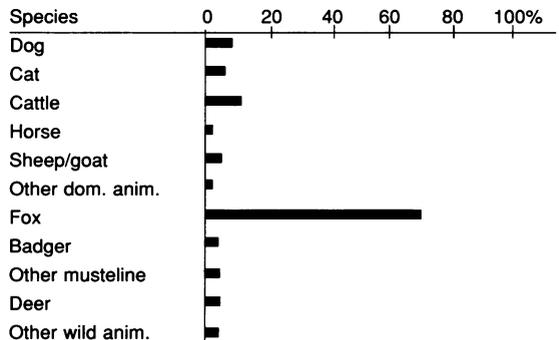
Module 5.11: Chronological time series of population health phenomena

Input data:

Indicator (variable), period: ? brucellosis cattle in C., 1960–1965

Number (up to 18) of data on time and variables: ? 10

List of data — subperiod or moment in chronological order (up to 15 characters), variable value (each except last must be greater than 0):

1 ? 1.7.1960, 92538

2 ? 1.1.1961, 106233

3 ? 1.7.1961, 105150

4 ? 1.1.1962, 88421

5 ? 1.7.1962, 81266

6 ? 1.1.1963, 68960

7 ? 1.7.1963, 48512

8 ? 1.1.1964, 28287

9 ? 1.7.1964, 13464

10 ? 1.1.1965, 0

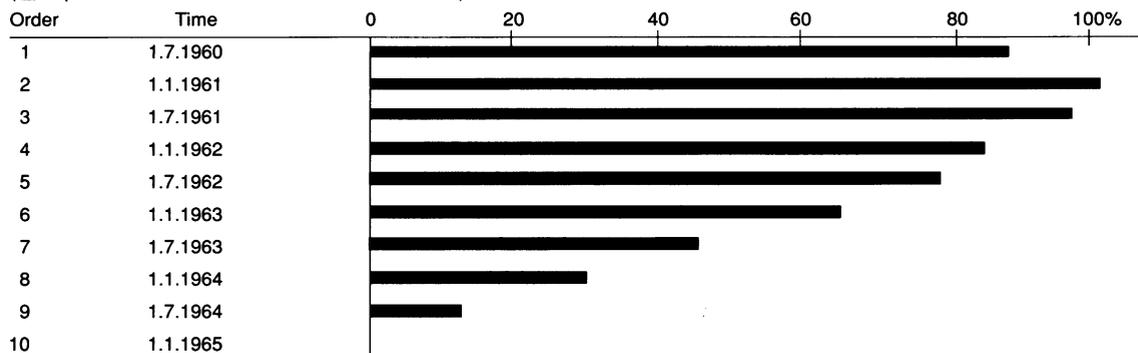## *Result*

Indicator (variable): brucellosis cattle in C.
Total period: 1960–1965

Order number	Subperiod/ moment	Variable value	Index Current	Chained
1	1.7.1960	92538.00	100.00	100.00
2	1.1.1961	106233.00	114.80	114.80
3	1.7.1961	105150.00	113.63	98.98
4	1.1.1962	88421.00	95.55	84.09
5	1.7.1962	81266.00	87.82	91.91
6	1.1.1963	68960.00	74.52	84.86
7	1.7.1963	48512.00	52.42	70.35
8	1.1.1964	28287.00	30.57	58.31
9	1.7.1964	13464.00	14.55	47.60
10	1.1.1965	0.00	0.00	0.00

Linear trend–adjusted line: $Y = 129902.20 - 12112.56 \, X$

Chronological time series of animal health phenomena

(■ represents 2% of the maximum of 106233.0000)

Order	Time	0	20	40	60	80	100%
1	1.7.1960						
2	1.1.1961						
3	1.7.1961						
4	1.1.1962						
5	1.7.1962						
6	1.1.1963						
7	1.7.1963						
8	1.1.1964						
9	1.7.1964						
10	1.1.1965						

Module 9.4: Planning of morbidity reduction (in curve form) (decrease of diseased animals number in regular curve form)

Input data:

Disease(s): ? bovine tuberculosis

Place: ? Country C.

Period: ? 1.1.1960–31.12.1968

Species, category(ies): ? cattle, all

Time measure unit: ? year

Number of diseased animals at the beginning of the programme: ? 859 557

Reduced number of diseased animals planned for the end of the programme: ? 0

Planned period for objective achievement (in time measure units): ? 9

Results

Disease(s): bovine tuberculosis   Period: 1.1.1960–1.1.1968

Place: Country C.

Species: cattle   Category(ies): all

Diseased animals initial number: 859 557   Final planned number: 0

Time (end of year)	Supposed number of diseased animals	Percentage of initial value
1	833 638	96.9846
2	759 008	88.3022
3	644 668	75.0000
4	504 409	58.6825
5	355 148	41.3176
6	214 889	25.0001
7	100 549	11.6978
8	25 919	3.0154
9	0	0.0000

Morbidity reduction in curve form

(■ represents 2% of initial 859 557 diseased animals)

End of year	0	20	40	60	80	100%

(Start)
1
2
3
4
5
6
7
8
9