

A desktop calculator for effect sizes: Towards the new statistics

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Abstract

Effect size is a statistical concept which measures the strength of the relationship between two variables. Effect size has basic properties such as measurement unit independence, sample size independence, and monotonicity. In particular, unlike statistical significance test, effect size is not influenced by sample size. Effect size avoids various problems in statistical significance tests. It is one of the important contents in constructing new statistics. In present study, various effect sizes were mathematically described and a free desktop calculator for effect sizes was presented.

Keywords effect sizes; calculation; offline; software; new statistics.

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1 Introduction

Statistical significance tests (including student's t -test, F -test, χ^2 -test, etc.) are one of the most important statistical inference methods in statistics (Fisher, 1935; Yates, 1951; Amrhein et al., 2019; Sellke et al., 2001; Xie, 2022). Researchers around the world widely use statistical significance as a certificate of scientific discovery. Whether a research result is statistically significant is mainly judged by the p -value obtained from hypothesis testing (Bergstrom and West, 2021). The p -value is at the heart of the statistical significance tests. Over the past few decades, statistical significance tests have been used in most statistics-related research papers, monographs, textbooks, and all statistical software worldwide, and numerous scientists in various disciplines have touted the p -value as the gold standard for statistical significance (Sun, 2016; Zhang, 2022c). However in recent years, statistical significance tests have been questioned unprecedentedly, mainly because the paradigm of significance tests is wrong, p -value is too sensitive, p -value is a dichotomous subjective index, and statistical significance is related to sample size, etc (Trafimow and Marks, 2015; Baker, 2016; Wasserstein and Lazar, 2016; McShane and David, 2017; Tong, 2019; Wasserstein et al., 2019; Zhang, 2022a-c). Statistical significance tests have been one of the sources of false conclusions and research reproducibility crisis (Ioannidis, 2005; Open Science Collaboration, 2015; Errington et al., 2021; Huang, 2021a-b; Kafdar, 2021; Nature Editorial, 2021; Vrieze, 2021; Zhang, 2022c). Actually, statistical significance mainly depends on the sample size, the quality of the data and the power of the statistical procedures (Lenhard and Lenhard, 2016;


```
unit Unit2;

interface

uses
  Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
  Dialogs, StdCtrls, ExtCtrls;

type
  TForm2 = class(TForm)
    Panel1: TPanel;
    Label1: TLabel;
    RadioButton1: TRadioButton;
    RadioButton2: TRadioButton;
    Label2: TLabel;
    Label3: TLabel;
    Edit1: TEdit;
    Edit2: TEdit;
    Edit3: TEdit;
    Edit4: TEdit;
    Label4: TLabel;
    Label5: TLabel;
    Label6: TLabel;
    Edit5: TEdit;
    Label7: TLabel;
    Edit6: TEdit;
    Label8: TLabel;
    Edit7: TEdit;
    Label9: TLabel;
    Edit8: TEdit;
    Label10: TLabel;
    Label11: TLabel;
    Edit9: TEdit;
    Edit10: TEdit;
    Label12: TLabel;
    Label13: TLabel;
    Edit11: TEdit;
    Edit12: TEdit;
    Edit13: TEdit;
    Edit14: TEdit;
    Timer1: TTimer;
    procedure RadioButton1Click(Sender: TObject);
    procedure RadioButton2Click(Sender: TObject);
    procedure Timer1Timer(Sender: TObject);
  private
    { Private declarations }
  public
    { Public declarations }
  end;
```

```
var
  Form2: TForm2;

implementation

{$R *.dfm}

procedure TForm2.RadioButton1Click(Sender: TObject);
begin
  label10.Enabled:=false;
  label11.Enabled:=false;
  edit9.Enabled:=false;
  edit10.Enabled:=false;
  label6.Enabled:=true;
  edit5.Enabled:=true;
  label8.Caption:='Glass effect size Δ: ';
  edit1.Text:='';
  edit2.Text:='';
  edit3.Text:='';
  edit4.Text:='';
  edit9.text:='';
  edit10.text:='';
end;

procedure TForm2.RadioButton2Click(Sender: TObject);
begin
  label6.Enabled:=false;
  edit5.Enabled:=false;
  label10.Enabled:=true;
  label11.Enabled:=true;
  edit9.Enabled:=true;
  edit10.Enabled:=true;
  label8.Caption:='Hedges" effect size g: ';
  edit1.Text:='';
  edit2.Text:='';
  edit3.Text:='';
  edit4.Text:='';
  edit5.text:='';
end;

procedure TForm2.Timer1Timer(Sender: TObject);
var
  m1, m2, s, s1, s2, x, cohend, gedgeg, glassd, cles, sigma, D, T: single;
  n, n1, n2: integer;
begin
  try
  m1:=strtofloat(trim(edit1.Text));
  m2:=strtofloat(trim(edit3.Text));
  s1:=strtofloat(trim(edit2.Text));
  s2:=strtofloat(trim(edit4.Text));
```

```

if (radiobutton1.checked=true) then
n:=strtoint(trim(edit5.Text))
else
begin
n1:=strtoint(trim(edit9.Text));
n2:=strtoint(trim(edit10.Text));
end;
except
edit6.Text:="";
edit7.Text:="";
edit8.Text:="";
edit11.Text:="";
edit12.Text:="";
edit13.Text:="";
edit14.Text:="";
exit;
end;
s:=sqrt(((n1-1)*s1*s1+(n2-1)*s2*s2)/(n1+n2-2));
cohend:=(m2-m1)/sqrt((s1*s1+s2*s2)/2);
if (radiobutton1.checked=true) then
begin
glassd:=(m2-m1)/s2;
sigma:=sqrt(4/n+cohend*cohend/(2*n));
x:=abs(m2-m1)/sqrt(s1*s1+s2*s2);
end
else
begin
gedgeg:=((m2-m1)/s)*(1-3/(4*(n1+n2-2)-1));
sigma:=sqrt((n1+n2)/(n1*n2)+0.5*cohend*cohend/(n1+n2));
x:=abs(cohend)/1.4142;
end;
D:=0.3989423*exp(-x*x/2);
T:=1/(1+0.2316419*abs(x));
cles:=D*T*(0.3193815+T*(-0.3565638+T*(1.781478+T*(-1.821256+T*1.330274))));
if (x>0) then
cles:=1-cles;
edit6.text:=floattostr(cohend);
edit11.text:=floattostr(cohend-1.96*sigma);
edit12.text:=floattostr(cohend+1.96*sigma);
edit13.text:=floattostr(cohend-1.65*sigma);
edit14.text:=floattostr(cohend+1.65*sigma);
if (radiobutton1.checked=true) then
edit7.text:=floattostr(glassd)
else
edit7.text:=floattostr(gedgeg);
edit8.text:=floattostr(cles);
end;

end.

```

```
unit Unit3;

interface

uses
  Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
  Dialogs, ExtCtrls, StdCtrls;

type
  TForm3 = class(TForm)
    Panel1: TPanel;
    Label1: TLabel;
    Label2: TLabel;
    Label3: TLabel;
    Edit1: TEdit;
    Edit2: TEdit;
    Edit3: TEdit;
    Label4: TLabel;
    Timer1: TTimer;
    procedure Timer1Timer(Sender: TObject);
  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
  Form3: TForm3;

implementation

{$R *.dfm}

procedure TForm3.Timer1Timer(Sender: TObject);
var
  r1, r2, q: single;
begin
  try
  r1:=strtofloat(trim(edit1.Text));
  r2:=strtofloat(trim(edit2.Text));
  except
  edit3.Text:="";
  exit;
  end;
  q:=abs(0.5*ln((1+r1)/(1-r1))-0.5*ln((1+r2)/(1-r2)));
  edit3.text:=floattostr(q);
end;

end.
```

```
unit Unit4;

interface

uses
  Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
  Dialogs, StdCtrls, ExtCtrls;

type
  TForm4 = class(TForm)
    Panel1: TPanel;
    Label1: TLabel;
    Edit1: TEdit;
    Edit2: TEdit;
    Edit3: TEdit;
    Edit4: TEdit;
    Edit5: TEdit;
    Edit6: TEdit;
    Edit7: TEdit;
    Edit8: TEdit;
    Label2: TLabel;
    Label3: TLabel;
    Label4: TLabel;
    Label5: TLabel;
    Label6: TLabel;
    Label7: TLabel;
    Label8: TLabel;
    Edit9: TEdit;
    Edit10: TEdit;
    Edit11: TEdit;
    Edit12: TEdit;
    Label9: TLabel;
    Label10: TLabel;
    Edit13: TEdit;
    Edit14: TEdit;
    Timer1: TTimer;
    procedure Timer1Timer(Sender: TObject);
  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
  Form4: TForm4;

implementation

{$R *.dfm}
```



```

procedure TForm4.Timer1Timer(Sender: TObject);
var
  m1pre, m1post, m2pre, m2post, s1pre, s1post, s2pre, s2post: single;
  n1pre, n1post, n2pre, n2post: integer;
  klauerd, morrisd, dpre, dpost, cp, spre: single;
begin
  try
    m1pre:=strtofloat(trim(edit1.Text));
    m1post:=strtofloat(trim(edit2.Text));
    m2pre:=strtofloat(trim(edit3.Text));
    m2post:=strtofloat(trim(edit4.Text));
    s1pre:=strtofloat(trim(edit5.Text));
    s1post:=strtofloat(trim(edit6.Text));
    s2pre:=strtofloat(trim(edit7.Text));
    s2post:=strtofloat(trim(edit8.Text));
    n1pre:=strtoint(trim(edit9.Text));
    n1post:=strtoint(trim(edit10.Text));
    n2pre:=strtoint(trim(edit11.Text));
    n2post:=strtoint(trim(edit12.Text));
  except
    edit13.Text:="";
    edit14.Text:="";
  end;
  exit;
end;
dpre:=(m1pre-m2pre)/sqrt((((n1pre-1)*s1pre*s1pre)+((n2pre-1)*s2pre*s2pre))/(n1pre+n2pre-2));
dpost:=(m1post-m2post)/sqrt((((n1post-1)*s1post*s1post)+((n2post-1)*s2post*s2post))/(n1post + n2post-2));
klauerd:=dpost-dpre;
cp:=1.0-(3.0/(4.0*(n1pre+n2pre-2.0)-1.0));
spre:=sqrt((((n1pre-1)*s1pre*s1pre)+((n2pre-1)*s2pre*s2pre))/(n1pre+n2pre-2));
morrisd:=cp*(((m1post-m1pre)-(m2post-m2pre))/spre);
edit13.text:=floattostr(klauerd);
edit14.text:=floattostr(morrisd);
end;

end.

unit Unit5;

interface

uses
  Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
  Dialogs, StdCtrls, ExtCtrls;

type
  TForm5 = class(TForm)
    Panel1: TPanel;
    Label1: TLabel;
    Label2: TLabel;
    Label3: TLabel;
  end;

```

```

Label4: TLabel;
Label5: TLabel;
Edit1: TEdit;
Edit2: TEdit;
Edit3: TEdit;
Edit4: TEdit;
Label6: TLabel;
Edit5: TEdit;
Label7: TLabel;
Edit6: TEdit;
Label8: TLabel;
Edit7: TEdit;
Label9: TLabel;
Edit8: TEdit;
Label10: TLabel;
Edit9: TEdit;
Edit10: TEdit;
Label11: TLabel;
Edit11: TEdit;
Edit12: TEdit;
Edit13: TEdit;
Label12: TLabel;
Timer1: TTimer;
procedure Timer1Timer(Sender: TObject);
private
  { Private declarations }
public
  { Public declarations }
end;

var
  Form5: TForm5;

implementation

{$R *.dfm}

procedure TForm5.Timer1Timer(Sender: TObject);
var
  m1, m2, s1, s2, r, s, sigma, drm, drmpooled, dav: single;
  n: integer;
begin
  try
    m1:=strtofloat(trim(edit1.Text));
    m2:=strtofloat(trim(edit2.Text));
    s1:=strtofloat(trim(edit3.Text));
    s2:=strtofloat(trim(edit4.Text));
    r:=strtofloat(trim(edit5.Text));
    n:=strtoint(trim(edit6.Text));
  except

```

```

edit7.Text:="";
edit8.Text:="";
edit9.Text:="";
edit10.Text:="";
edit11.Text:="";
edit12.Text:="";
edit13.Text:="";
exit;
end;
s:=sqrt(s1*s1+s2*s2-2*r*s1*s2);
drm:=((m2-m1)/s1)/sqrt(2*(1-r));
drmpooled:=((m2-m1)/s)/sqrt(2*(1-r));
sigma:=sqrt(2/n+drm*drm/(4*n));
dav:=(m2-m1)/((s1+s2)/2);
edit7.text:=floattostr(drm);
edit8.text:=floattostr(drmpooled);
edit9.text:=floattostr(drmpooled-1.96*sigma);
edit10.text:=floattostr(drmpooled+1.96*sigma);
edit11.text:=floattostr(drmpooled-1.65*sigma);
edit12.text:=floattostr(drmpooled+1.65*sigma);
edit13.text:=floattostr(dav);
end;

end.

unit Unit6;

interface

uses
  Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
  Dialogs, ExtCtrls, StdCtrls;

type
  TForm6 = class(TForm)
    Panel1: TPanel;
    Label1: TLabel;
    Label2: TLabel;
    Label3: TLabel;
    Label4: TLabel;
    Edit1: TEdit;
    Edit4: TEdit;
    Label5: TLabel;
    Timer1: TTimer;
    Edit2: TEdit;
    Edit3: TEdit;
    procedure Timer1Timer(Sender: TObject);
  private
    { Private declarations }
  public

```

```
    { Public declarations }
end;

var
    Form6: TForm6;

implementation

{$R *.dfm}

procedure TForm6.Timer1Timer(Sender: TObject);
var
    f, cohend: single;
    n1, n2: integer;
begin
    try
        f:=strtofloat(trim(edit1.Text));
        n1:=strtoint(trim(edit2.Text));
        n2:=strtoint(trim(edit3.Text));
    except
        edit4.Text:="";
    end;
    exit;
end;
cohend:=sqrt(f*((n1+n2)/(n1*n2))*((n1+n2)/(n1+n2-2)));
edit4.text:=floattostr(cohend);
end;

end.

unit Unit7;

interface

uses
    Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
    Dialogs, ExtCtrls, StdCtrls;

type
    TForm7 = class(TForm)
        Panel1: TPanel;
        Label1: TLabel;
        RadioButton1: TRadioButton;
        RadioButton2: TRadioButton;
        RadioButton3: TRadioButton;
        Label2: TLabel;
        Label3: TLabel;
        Label4: TLabel;
        Label5: TLabel;
        Label6: TLabel;
        Edit1: TEdit;
```

```

    Edit2: TEdit;
    Edit3: TEdit;
    Edit4: TEdit;
    Label7: TLabel;
    Edit5: TEdit;
    Label8: TLabel;
    Edit6: TEdit;
    Timer1: TTimer;
    procedure Timer1Timer(Sender: TObject);
    procedure RadioButton1Click(Sender: TObject);
    procedure RadioButton2Click(Sender: TObject);
    procedure RadioButton3Click(Sender: TObject);
private
    { Private declarations }
public
    { Public declarations }
end;

var
    Form7: TForm7;

implementation

{$R *.dfm}

procedure TForm7.Timer1Timer(Sender: TObject);
var
    mmax, mmin, s, cohenf, cohend: single;
    k: integer;
begin
    try
    mmax:=strtofloat(trim(edit1.Text));
    mmin:=strtofloat(trim(edit2.Text));
    s:=strtofloat(trim(edit3.Text));
    k:=strtoint(trim(edit6.Text));
    except
    edit4.Text:="";
    edit5.Text:="";
    exit;
    end;
    cohend:=(mmax-mmin)/s;
    if (radiobutton1.checked=true) then
    cohenf:=cohend*sqrt(1/(2*k))
    else
    if (radiobutton2.checked=true) then
    cohenf:=0.5*cohend*sqrt((k+1)/(3*(k-1)))
    else
    begin
    if((k mod 2)=0) then
    cohenf:=0.5*cohend

```

```
else
cohenf:=cohend*sqrt(k*k-1)/(2*k);
end;
edit4.text:=floattostr(cohenf);
edit5.text:=floattostr(cohend);
end;

procedure TForm7.RadioButton1Click(Sender: TObject);
begin
edit1.Text:="";
edit2.Text:="";
edit3.Text:="";
edit6.Text:="";
edit4.Text:="";
edit5.Text:="";
end;

procedure TForm7.RadioButton2Click(Sender: TObject);
begin
edit1.Text:="";
edit2.Text:="";
edit3.Text:="";
edit6.Text:="";
edit4.Text:="";
edit5.Text:="";
end;

procedure TForm7.RadioButton3Click(Sender: TObject);
begin
edit1.Text:="";
edit2.Text:="";
edit3.Text:="";
edit6.Text:="";
edit4.Text:="";
edit5.Text:="";
end;

end.
unit Unit8;

interface

uses
  Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
  Dialogs, ExtCtrls, StdCtrls;

type
  TForm8 = class(TForm)
    Panel1: TPanel;
    RadioButton1: TRadioButton;
```

```
RadioButton2: TRadioButton;
Label1: TLabel;
Edit1: TEdit;
Label2: TLabel;
Edit2: TEdit;
Label3: TLabel;
Edit3: TEdit;
Label4: TLabel;
Edit4: TEdit;
Label5: TLabel;
Edit5: TEdit;
Label6: TLabel;
Label7: TLabel;
Timer1: TTimer;
procedure RadioButton2Click(Sender: TObject);
procedure RadioButton1Click(Sender: TObject);
procedure Timer1Timer(Sender: TObject);
private
  { Private declarations }
public
  { Public declarations }
end;

var
  Form8: TForm8;

implementation

{$R *.dfm}

procedure TForm8.RadioButton1Click(Sender: TObject);
begin
label3.Enabled:=false;
edit3.Enabled:=false;
edit4.Enabled:=true;
edit1.text:="";
edit2.text:="";
edit3.text:="";
edit4.text:="";
end;

procedure TForm8.RadioButton2Click(Sender: TObject);
begin
edit4.Enabled:=false;
label3.Enabled:=true;
edit3.Enabled:=true;
edit1.text:="";
edit2.text:="";
edit3.text:="";
edit4.text:="";
```

```
end;

procedure TForm8.Timer1Timer(Sender: TObject);
var
    cohend, t, r: single;
    n1, n2: integer;
begin
    try
        t:=strtofloat(trim(edit1.Text));
        n1:=strtoint(trim(edit2.Text));
        if (radiobutton1.checked=true) then
            begin
                r:=strtofloat(trim(edit4.Text));
                cohend:=t*sqrt(2.0*(1.0-r)/n1)
            end
        else
            begin
                n2:=strtoint(trim(edit3.Text));
                cohend:=t*sqrt((n1+n2)/(n1*n2));
            end;
        except
            edit5.Text:="";
        end;
        edit5.text:=floattostr(cohend);
    end;

end.

unit Unit9;

interface

uses
    Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
    Dialogs, StdCtrls, Math, ExtCtrls;

type
    TForm9 = class(TForm)
        Panel1: TPanel;
        Label1: TLabel;
        RadioButton1: TRadioButton;
        RadioButton2: TRadioButton;
        RadioButton3: TRadioButton;
        Label2: TLabel;
        Edit1: TEdit;
        Label3: TLabel;
        Edit2: TEdit;
        Label4: TLabel;
        Edit3: TEdit;
    end;
```



```

Label5: TLabel;
Edit4: TEdit;
Timer1: TTimer;
Label6: TLabel;
Edit5: TEdit;
procedure Timer1Timer(Sender: TObject);
procedure RadioButton1Click(Sender: TObject);
procedure RadioButton2Click(Sender: TObject);
procedure RadioButton3Click(Sender: TObject);
private
  { Private declarations }
public
  { Public declarations }
end;

var
  Form9: TForm9;

implementation

{$R *.dfm}

procedure TForm9.Timer1Timer(Sender: TObject);
var
  d, r, rs, x2, h2, z: single;
  n, RR, CC: integer;
begin
  try
  if (radiobutton1.checked=true) then
  begin
  x2:=strtofloat(trim(edit1.Text));
  n:=strtoint(trim(edit4.Text));
  r:=sqrt(x2/n);
  d:=2*r/sqrt(1-r*r);
  h2:=(d/2)*(d/2)/(1+(d/2)*(d/2))
  end
  else
  if (radiobutton2.checked=true) then
  begin
  x2:=strtofloat(trim(edit1.Text));
  RR:=strtoint(trim(edit2.Text));
  CC:=strtoint(trim(edit4.Text));
  rs:=sqrt(x2/min(CC-1,RR-1));
  end
  else
  begin
  z:=strtofloat(trim(edit2.Text));
  n:=strtoint(trim(edit4.Text));
  r:=z/sqrt(n);
  d:=2*r/sqrt(1-r*r);

```

```
h2:=(d/2)*(d/2)/(1+(d/2)*(d/2));
end;
except
edit3.Text:="";
edit5.Text:="";
exit;
end;
if (radiobutton2.checked=true) then
edit3.text:=floattostr(rs);
if ((radiobutton1.checked=true) or (radiobutton3.checked=true)) then
begin
edit3.text:=floattostr(d);
edit5.text:=floattostr(h2);
end;
end;
```

```
procedure TForm9.RadioButton1Click(Sender: TObject);
begin
label3.Enabled:=false;
edit2.Enabled:=false;
label2.Enabled:=true;
edit1.Enabled:=true;
label6.Enabled:=true;
edit5.Enabled:=true;
label3.Caption:='z-value (z)';
label5.Caption:='Sample size (n)';
label4.Caption:='Effect size d';
edit1.Text:="";
edit2.Text:="";
edit3.Text:="";
edit4.Text:="";
edit5.Text:="";
end;
```

```
procedure TForm9.RadioButton2Click(Sender: TObject);
begin
label5.Enabled:=false;
edit4.Enabled:=false;
label6.Enabled:=false;
edit5.Enabled:=false;
label2.Enabled:=true;
edit1.Enabled:=true;
label3.Enabled:=true;
edit2.Enabled:=true;
label5.Enabled:=true;
edit4.Enabled:=true;
label3.Caption:='No. rows (R)';
label5.Caption:='No. columns (C)';
label4.Caption:='Effect size r';
edit1.Text:="";
```

```
edit2.Text:="";
edit3.Text:="";
edit4.Text:="";
edit5.Text:="";
end;

procedure TForm9.RadioButton3Click(Sender: TObject);
begin
label2.Enabled:=false;
edit1.Enabled:=false;
edit4.Enabled:=true;
edit5.Enabled:=true;
label6.Enabled:=true;
label3.Enabled:=true;
edit2.Enabled:=true;
label3.Caption:='z-value (z)';
label5.Caption:='Sample size (n)';
label4.Caption:='Effect size d';
edit1.Text:="";
edit2.Text:="";
edit3.Text:="";
edit4.Text:="";
edit5.Text:="";
end;

end.

unit Unit10;

interface

uses
  Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
  Dialogs, StdCtrls, ExtCtrls;

type
  TForm10 = class(TForm)
    Panel1: TPanel;
    Label1: TLabel;
    Label2: TLabel;
    Edit1: TEdit;
    Label3: TLabel;
    Edit2: TEdit;
    Timer1: TTimer;
    procedure Timer1Timer(Sender: TObject);
  private
    { Private declarations }
  public
    { Public declarations }
  end;
```

```
var
  Form10: TForm10;

implementation

{$R *.dfm}

procedure TForm10.Timer1Timer(Sender: TObject);
var
  b, r: single;
begin
  try
    b:=strtofloat(trim(edit1.Text));
    if ((b>=-0.5) and (b<=0.5)) then
      if (b>=0) then
        r:=b+0.05
      else r:=b;
    except
      edit2.Text:="";
    end;
    if ((b>=-0.5) and (b<=0.5)) then
      edit2.text:=floattostr(r)
    else
      edit2.text:="";
    end;

  end.

unit Unit11;

interface

uses
  Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
  Dialogs, ExtCtrls, StdCtrls;

type
  TForm11 = class(TForm)
    Panel1: TPanel;
    Label1: TLabel;
    RadioButton1: TRadioButton;
    RadioButton2: TRadioButton;
    RadioButton3: TRadioButton;
    Label2: TLabel;
    Edit1: TEdit;
    Label3: TLabel;
    Label4: TLabel;
    Edit2: TEdit;
```

```
    Edit3: TEdit;
    Label5: TLabel;
    Edit4: TEdit;
    Label6: TLabel;
    Edit5: TEdit;
    Timer1: TTimer;
    procedure RadioButton1Click(Sender: TObject);
    procedure RadioButton2Click(Sender: TObject);
    procedure RadioButton3Click(Sender: TObject);
    procedure Timer1Timer(Sender: TObject);
private
    { Private declarations }
public
    { Public declarations }
end;

var
    Form11: TForm11;

implementation

{$R *.dfm}

procedure TForm11.RadioButton1Click(Sender: TObject);
begin
    label2.Caption:='Test statistic U value:';
    label4.enabled:=true;
    edit3.Enabled:=true;
    label3.Caption:='Sample size for group 1 (n1):';
    label4.Caption:='Sample size for group 2 (n2):';
    edit1.Text:='';
    edit2.Text:='';
    edit3.Text:='';
    edit4.Text:='';
    edit5.Text:='';
end;

procedure TForm11.RadioButton2Click(Sender: TObject);
begin
    label2.Caption:='Test statistic W value:';
    label3.Caption:='Total sample size (n):';
    label4.enabled:=false;
    edit3.Enabled:=false;
    edit1.Text:='';
    edit2.Text:='';
    edit3.Text:='';
    edit4.Text:='';
    edit5.Text:='';
end;
```

```

procedure TForm11.RadioButton3Click(Sender: TObject);
begin
label2.Caption:='Test statistic H value:.';
label4.enabled:=true;
edit3.Enabled:=true;
label3.Caption:='Total sample size (n):.';
label4.Caption:='Number of groups (k):.';
edit1.Text:='';
edit2.Text:='';
edit3.Text:='';
edit4.Text:='';
edit5.Text:='';
end;

procedure TForm11.Timer1Timer(Sender: TObject);
var
    U, W, H, z, cohend, h2: single;
    n, n1, n2, k: integer;
begin
try
if (radiobutton1.checked=true) then
begin
U:=strtofloat(trim(edit1.Text));
n1:=strtoint(trim(edit2.Text));
n2:=strtoint(trim(edit3.Text));
z:=(U-(n1*n2/2))/sqrt(n1*n2*(n1+n2+1)/12);
if(z<0) then
z:=-z;
h2:=z*z/(n1+n2);
if(h2<0) then
h2:=-h2;
end
else
if (radiobutton2.checked=true) then
begin
W:=strtofloat(trim(edit1.Text));
n:=strtoint(trim(edit2.Text));
z:=(W-(n*(n+1)))/sqrt(n*(n+1)*(2*n+1)/24);
if(z<0) then
z:=-z;
h2:=z*z/n;
if(h2<0) then
h2:=-h2;
end
else
begin
H:=strtofloat(trim(edit1.Text));
n:=strtoint(trim(edit2.Text));
k:=strtoint(trim(edit3.Text));
h2:=abs((H-k+1)/(n-k));

```

```
end;
except
edit4.Text:="";
edit5.Text:="";
exit;
end;
edit4.text:=floattostr(h2);
try
cohend:=2*sqrt(h2/(1-h2));
except
exit;
end;
edit5.text:=floattostr(cohend);
end;

end.

unit Unit12;

interface

uses
  Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
  Dialogs, StdCtrls, ExtCtrls;

type
  TForm12 = class(TForm)
    Panel1: TPanel;
    Label1: TLabel;
    Label2: TLabel;
    Label3: TLabel;
    Label4: TLabel;
    Label5: TLabel;
    Label6: TLabel;
    Label7: TLabel;
    Label8: TLabel;
    Edit1: TEdit;
    Edit4: TEdit;
    Edit5: TEdit;
    Edit6: TEdit;
    Edit7: TEdit;
    Label9: TLabel;
    Edit2: TEdit;
    Edit3: TEdit;
    Edit8: TEdit;
    Timer1: TTimer;
    procedure Timer1Timer(Sender: TObject);
  private
    { Private declarations }
  public
```

```
    { Public declarations }
end;

var
    Form12: TForm12;

implementation

{$R *.dfm}

procedure TForm12.Timer1Timer(Sender: TObject);
var
    a, b, c, d, n1, n2, RR, ORR, RD, YuleQ: single;
begin
    try
        a:=strtofloat(trim(edit4.Text));
        b:=strtofloat(trim(edit5.Text));
        c:=strtofloat(trim(edit6.Text));
        d:=strtofloat(trim(edit7.Text));
        n1:=a+b;
        n2:=c+d;
        RR:=(a/n1)/(c/n2);
        ORR:=(a*d)/(b*c);
        YuleQ:=(ORR-1)/(ORR+1);
        RD:=a/n1-c/n2;
    except
        edit1.Text:="";
        edit2.Text:="";
        edit3.Text:="";
        edit8.Text:="";
    exit;
    end;
    edit1.text:=floattostr(RR);
    edit2.text:=floattostr(ORR);
    edit3.text:=floattostr(YuleQ);
    edit8.text:=floattostr(RD);
end;

end.

unit Unit13;

interface

uses
    Windows, Messages, SysUtils, Variants, Classes, Graphics, Controls, Forms,
    Dialogs, StdCtrls, ExtCtrls;

type
    TForm13 = class(TForm)
```



```
Panel1: TPanel;
Label1: TLabel;
RadioButton1: TRadioButton;
RadioButton2: TRadioButton;
Label2: TLabel;
Edit1: TEdit;
Label3: TLabel;
Edit2: TEdit;
Label4: TLabel;
Edit3: TEdit;
Label5: TLabel;
Label6: TLabel;
Edit4: TEdit;
Edit5: TEdit;
Label7: TLabel;
Edit6: TEdit;
Timer1: TTimer;
procedure RadioButton1Click(Sender: TObject);
procedure RadioButton2Click(Sender: TObject);
procedure Timer1Timer(Sender: TObject);
private
  { Private declarations }
public
  { Public declarations }
end;

var
  Form13: TForm13;

implementation

{$R *.dfm}

procedure TForm13.RadioButton1Click(Sender: TObject);
begin
label5.Enabled:=false;
label6.Enabled:=false;
label7.Enabled:=false;
edit4.Enabled:=false;
edit5.Enabled:=false;
edit6.Enabled:=false;
label2.Enabled:=true;
label3.Enabled:=true;
label4.Enabled:=true;
edit1.Enabled:=true;
edit2.Enabled:=true;
edit3.Enabled:=true;
edit4.text:="";
edit5.text:="";
edit6.text:="";
```

```
end;

procedure TForm13.RadioButton2Click(Sender: TObject);
begin
label2.Enabled:=false;
label3.Enabled:=false;
label4.Enabled:=false;
edit1.Enabled:=false;
edit2.Enabled:=false;
edit3.Enabled:=false;
label5.Enabled:=true;
label6.Enabled:=true;
label7.Enabled:=true;
edit4.Enabled:=true;
edit5.Enabled:=true;
edit6.Enabled:=true;
edit1.text:="";
edit2.text:="";
edit3.text:="";
end;

procedure TForm13.Timer1Timer(Sender: TObject);
var
    F, SSA, SSE, cohenf, hp2: single;
    k: integer;
begin
try
if (radiobutton1.checked=true) then
begin
F:=strtofloat(trim(edit1.Text));
k:=strtoint(trim(edit2.Text));
cohenf:=sqrt(F/k);
edit3.text:=floattostr(cohenf)
end
else
begin
SSA:=strtofloat(trim(edit4.Text));
SSE:=strtofloat(trim(edit5.Text));
hp2:=SSA/(SSA+SSE);
edit6.text:=floattostr(hp2);
end;
except
if (radiobutton1.checked=true) then
edit3.Text:=""
else
edit6.Text:="";
exit;
end;
end;
```

end.

Figs. 1-13 show the main window and the windows of calculator for different effect sizes. The calculator and user manual guide can be freely downloaded at:

[http://www.iaees.org/publications/journals/ces/articles/2023-13\(4\)/e-suppl/Zhang-Supplementary-Materials.rar](http://www.iaees.org/publications/journals/ces/articles/2023-13(4)/e-suppl/Zhang-Supplementary-Materials.rar)

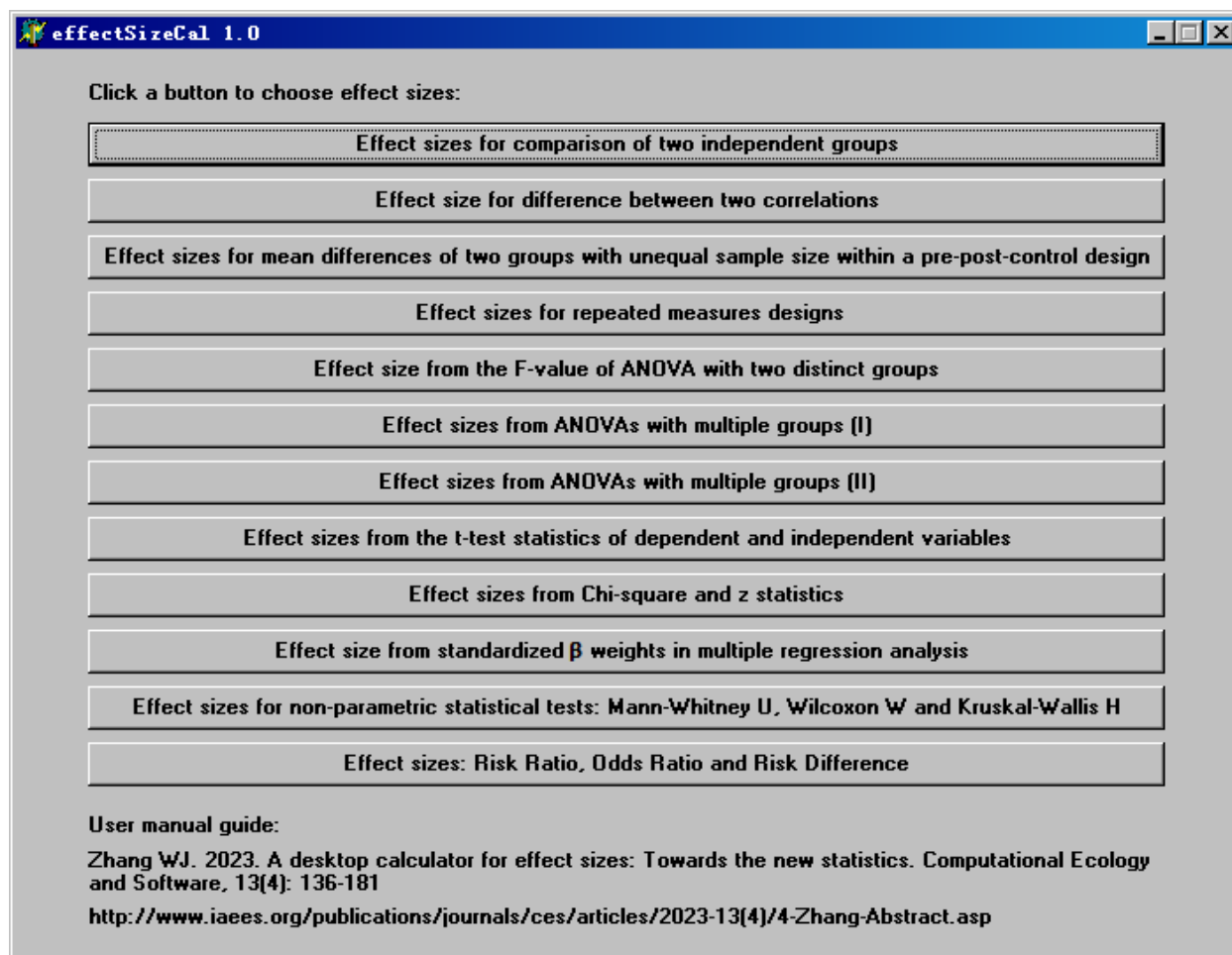


Fig. 1 Main window of the calculator.

Fig. 2 The window of effect sizes for difference comparison of two independent groups.

Fig. 3 The window of effect size for difference between two correlations.

Effect sizes for mean differences of two groups with unequal sample size within a pre-post-control design

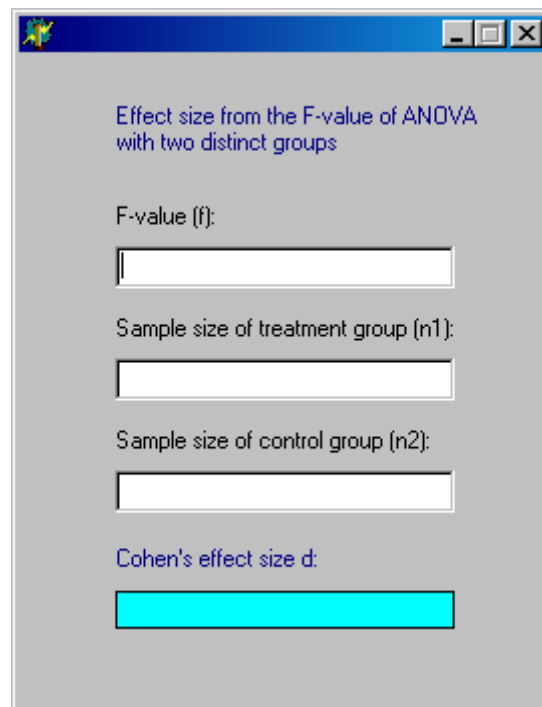
	Intervention Pre	Intervention Post	Control Pre	Control Post
Mean (m):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Standard deviation (s):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Sample size (n):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Klauer's effect size d:	<input type="text"/>			
Morris' effect size d:	<input type="text"/>			

Fig. 4 The window of effect sizes for mean differences of two groups with unequal sample size within a pre-post-control design.

Effect sizes for repeated measures designs

	Group 1	Group 2
Mean (m):	<input type="text"/>	<input type="text"/>
Standard deviation (s):	<input type="text"/>	<input type="text"/>
Between-group correlation (r):	<input type="text"/>	
Pooled sample size (n):	<input type="text"/>	
Effect size d_m :	<input type="text"/>	
Effect size d_m pooled:	<input type="text"/>	
95% Confid. Interval of d_m pooled:	<input type="text"/>	<input type="text"/>
90% Confid. Interval of d_m pooled:	<input type="text"/>	<input type="text"/>
Cumming's effect size d_{av} :	<input type="text"/>	

Fig. 5 The window of effect sizes for repeated measures designs.



Effect size from the F-value of ANOVA
with two distinct groups

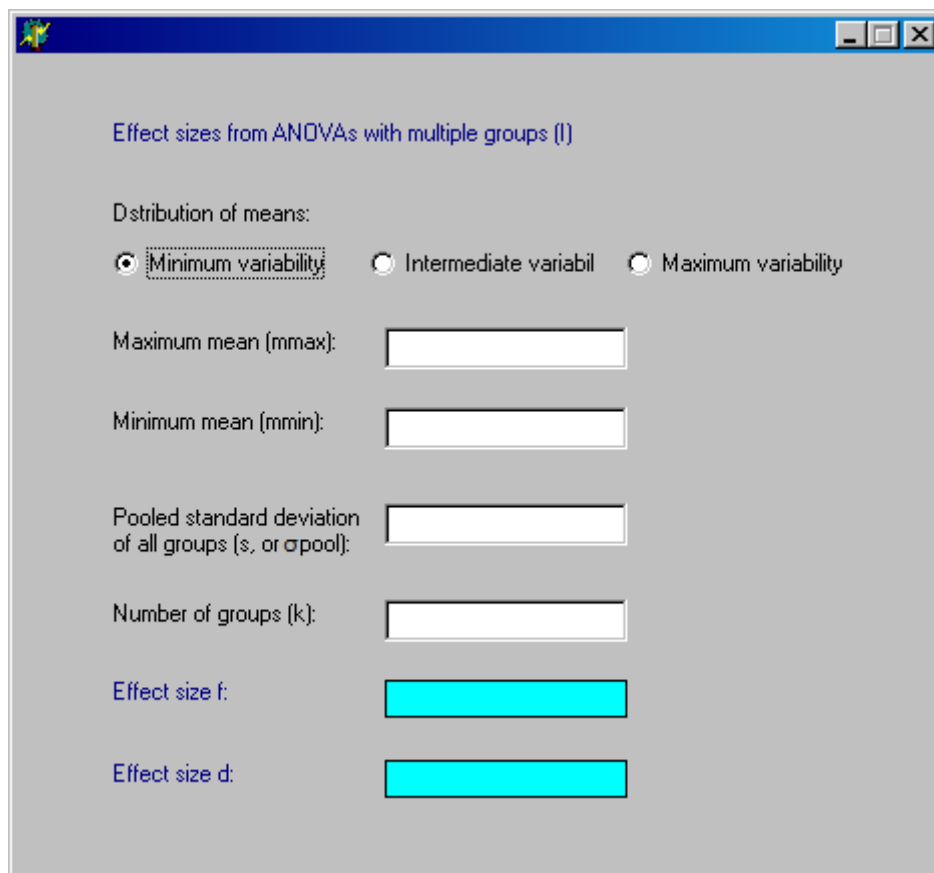
F-value (f):

Sample size of treatment group (n1):

Sample size of control group (n2):

Cohen's effect size d:

Fig. 6 The window of effect sizes from the F -value of ANOVA with two distinct groups.



Effect sizes from ANOVAs with multiple groups (I)

Distribution of means:
 Minimum variability Intermediate variabil Maximum variability

Maximum mean (mmax):

Minimum mean (mmin):

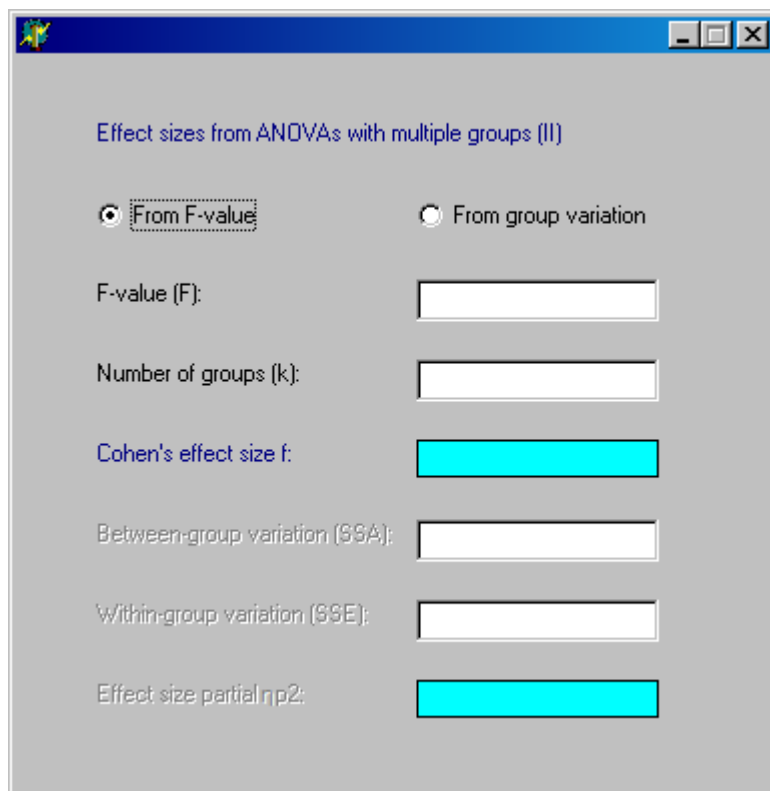
Pooled standard deviation
of all groups (s, or σ_{pool}):

Number of groups (k):

Effect size f:

Effect size d:

Fig. 7 The window of effect sizes from ANOVAs with multiple groups (I).



Effect sizes from ANOVAs with multiple groups (II)

From F-value From group variation

F-value (F):

Number of groups (k):

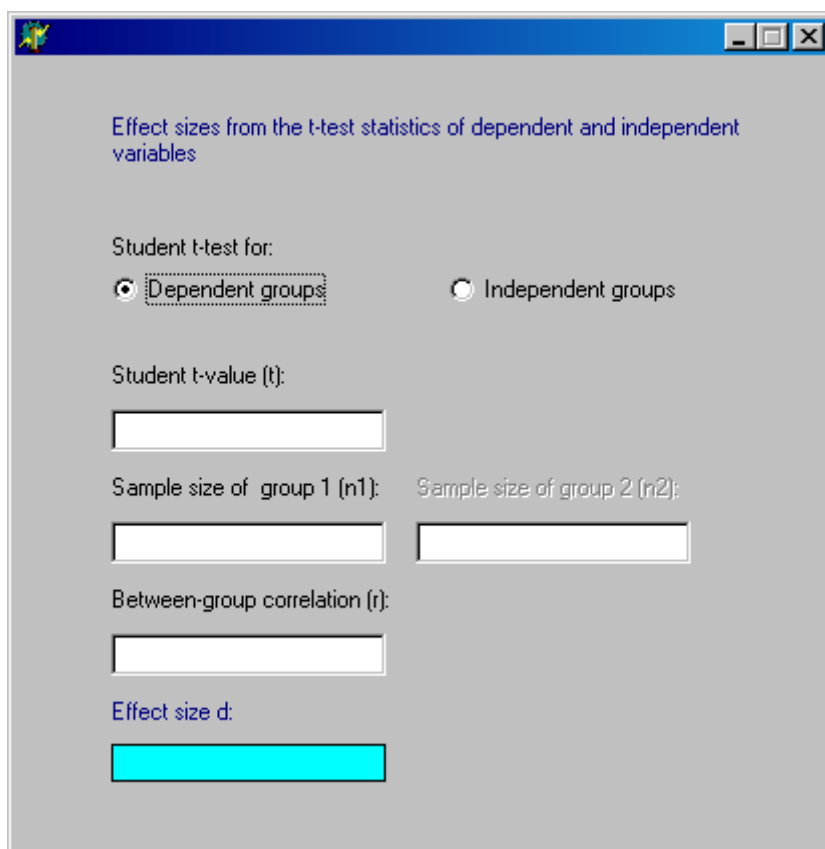
Cohen's effect size f:

Between-group variation (SSA):

Within-group variation (SSE):

Effect size partial η^2 :

Fig. 8 The window of effect sizes from ANOVAs with multiple groups (II).



Effect sizes from the t-test statistics of dependent and independent variables

Student t-test for:

Dependent groups Independent groups

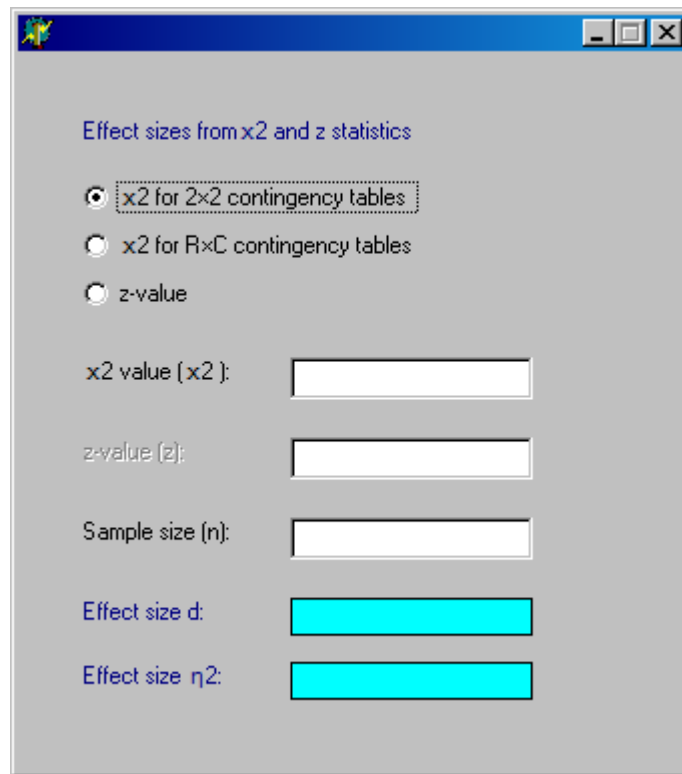
Student t-value (t):

Sample size of group 1 (n1): Sample size of group 2 (n2):

Between-group correlation (r):

Effect size d:

Fig. 9 The window of effect sizes from the *t*-test statistics of dependent and independent variables.



Effect sizes from χ^2 and z statistics

χ^2 for 2x2 contingency tables

χ^2 for RxC contingency tables

z-value

χ^2 value (χ^2):

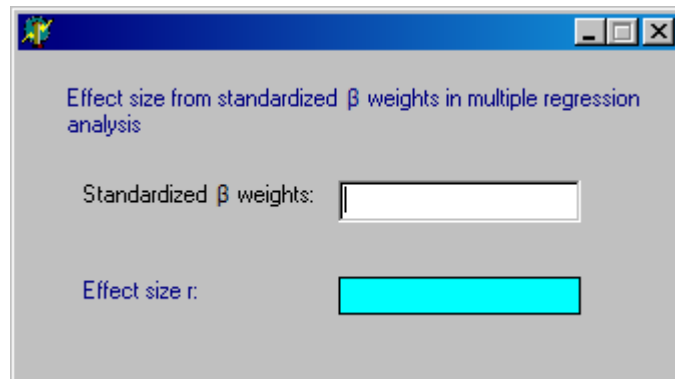
z-value (z):

Sample size (n):

Effect size d:

Effect size η^2 :

Fig. 10 The window of effect sizes from χ^2 and z statistics.

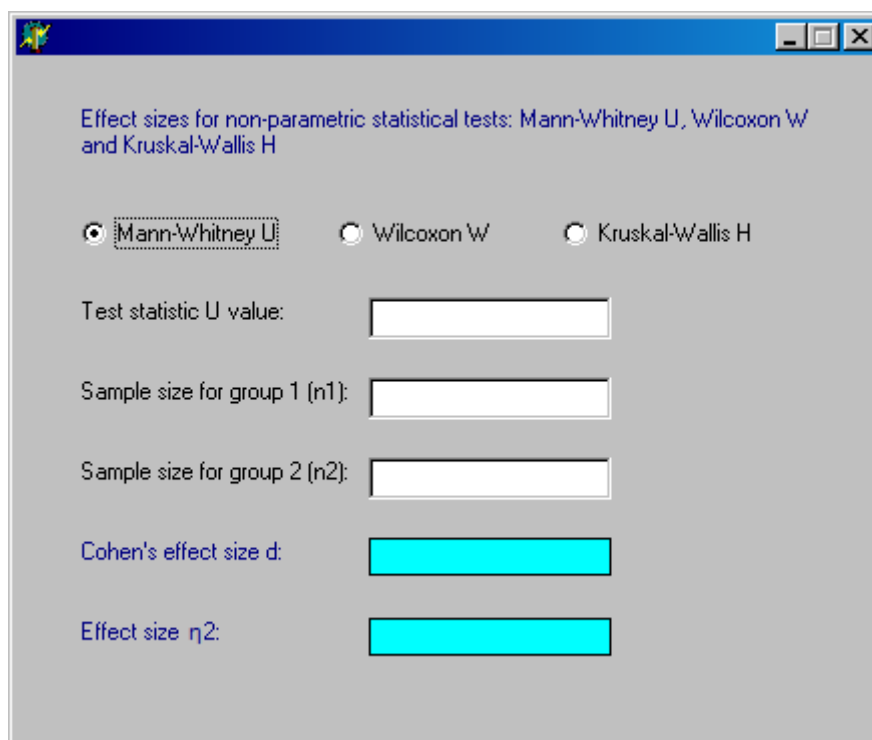


Effect size from standardized β weights in multiple regression analysis

Standardized β weights:

Effect size r:

Fig. 11 The window of effect sizes from standardized β weights in multiple regression analysis.



Effect sizes for non-parametric statistical tests: Mann-Whitney U , Wilcoxon W and Kruskal-Wallis H

Mann-Whitney U Wilcoxon W Kruskal-Wallis H

Test statistic U value:

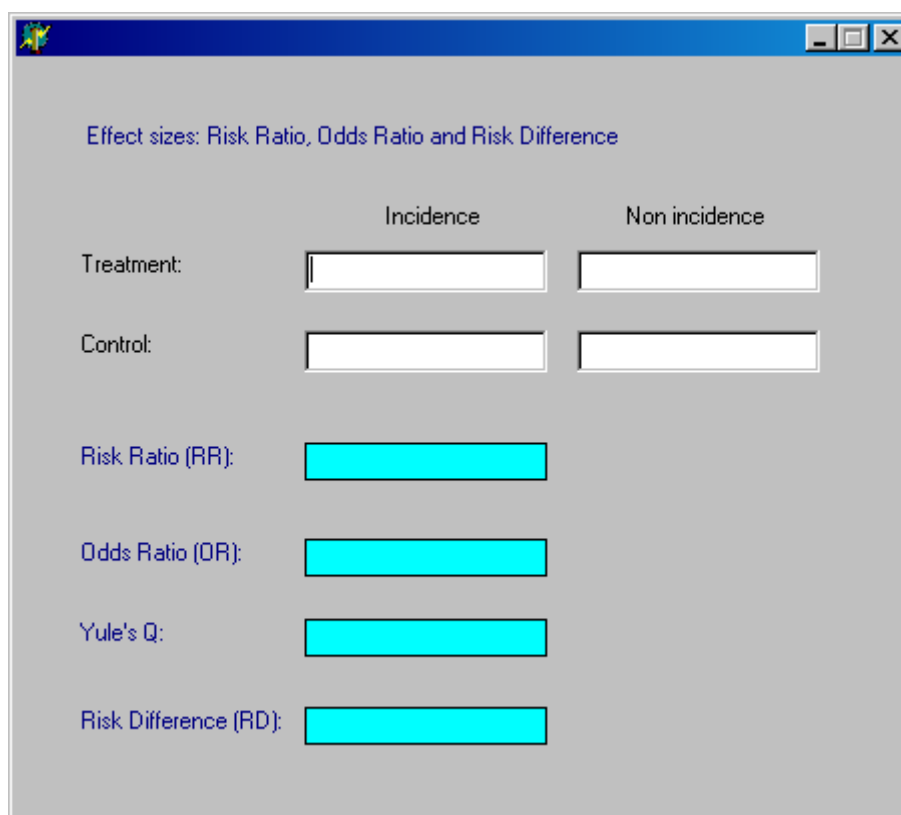
Sample size for group 1 (n_1):

Sample size for group 2 (n_2):

Cohen's effect size d :

Effect size η^2 :

Fig. 12 The window of effect sizes for non-parametric statistical tests: Mann-Whitney U , Wilcoxon W and Kruskal-Wallis H .



Effect sizes: Risk Ratio, Odds Ratio and Risk Difference

	Incidence	Non incidence
Treatment:	<input type="text"/>	<input type="text"/>
Control:	<input type="text"/>	<input type="text"/>

Risk Ratio (RR):

Odds Ratio (OR):

Yule's Q :

Risk Difference (RD):

Fig. 13 The window of effect sizes Risk Ratio, Odds Ratio and Risk Difference.

4 Role of Effect Sizes in Complementing Statistical Significance Tests: An Explanatory Example

In the statistical significance tests, the sample size n , the mean m and the standard deviation s , t -value or F -value, χ^2 -value, etc., are usually given. Based on these statistics, the effect sizes d and η^2 , etc., can be calculated. Reporting both the p -value and the effect sizes can complement each other (Li, 2021; Zhang, 2022c).

As indicated above, η^2 is one of the most commonly used effect sizes. A literature example may illustrate the match and difference between p -value and effect size (η^2) (Zarkadi and Schnall, 2013; Li, 2021; Zhang, 2022c). In this example, the researchers examine the influence of black and white background or gray background (priming condition) on moral judgment. The experimental material include 6 social issues (pornography, adultery, drug use, littering, smoking, use of profanity), and people are asked to rate their morality on a scale of -5 (very immoral) to +5 (very moral). The researchers predict that priming with black and white visual contrast may lead to more extreme morality than non-priming judgment (Zarkadi and Schnall, 2013).

The researchers propose an index for deviation score, the distance between the results of the subjective judgment and the midpoint of the scale, to evaluate the extreme situation of moral judgment. They find that the mean of deviation score under the black and white condition ($m=2.50$, $s=0.96$) is greater than the mean of deviation scores under the grey condition ($m=2.05$, $s=0.91$) ($F(1,128)=7.35$, $p=0.008$, $\eta^2=0.05$). When the researchers analyze the 6 items separately, they demonstrate the same pattern of smoking ($F(1,128)=5.69$, $p=0.02$, $\eta^2=0.04$), and drug use ($F(1,128)=4.31$, $p=0.04$, $\eta^2=0.03$), adultery ($F(1,128)=8.34$, $p=0.005$, $\eta^2=0.06$), and the priming condition effect is significant. Additionally, the difference in mean severity of the two priming conditions (black and white condition: $m=-1.79$, $s=1.57$; grey condition: $m=-1.05$, $s=1.32$) ($F(1,128)=1.05$, $p=0.31$, $\eta^2=0.008$) is not significant. Comparing the above p -value and the effect size η^2 , it can be concluded that p -value is much more sensitive than the effect size η^2 (Li, 2021; Zhang, 2022c).

Obviously it can be found that the two indicators of the p -value and the effect size η^2 have complementary effects. For example, the contrasting background of black and white will polarize moral judgments and the polarization relates to specific social issues. At the same time, the impact on adultery judgments ($p=0.005$, $\eta^2=0.06$) versus smoking judgment ($p=0.02$, $\eta^2=0.04$) is more obvious. It is particularly remarkable that the effect size of the black and white contrast background on the severity of moral judgments is so small ($\eta^2=0.008$), implying that the impact of black and white contrast on moral judgments should not be examined with severity. Even if the sample size is enlarged and the power is improved, it does not produce much more sense. The research shows that the effect of black and white contrast on the polarization of moral judgment does not reach the standard of small effect size. The impact of black and white contrast on moral judgment is quite subtle. Thus if you want to repeat the study, you need to pay attention to improving the power (e.g., increasing the sample size), otherwise you may not get significant results. This example strongly suggests that reporting both the p -value and the effect size can complement each other (Li, 2021; Zhang, 2022c).

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